AN INPUT - OUTPUT STUDY OF INDUSTRIAL WATER POLLUTION IN INDIA

A Thesis Submitted
in Partial Fulfilment of the Requirements
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Doctor of Philosophy

by

APARNA MISHRA

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CERTIFICATE

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Synopsis

An Input-Output Study of Industrial Water Pollution in India

A Thesis Submitted in Partial Fulfilment of the Degree of PhD
By

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During the past few decades Indian industries have registered a quantum jump, which has contributed to high economic growth but simultaneously it has also given rise to severe environmental pollution. Consequently, ambient air and water quality is seriously affected which is far lower in comparison to the international standards. The problem is worse in the case of water pollution. It is found that one-third of the total water pollution comes in the form of effluent discharge, solid wastes and other hazardous wastes. Untreated or allegedly treated effluents have increase the level of toxins in water, like cyanide and chromium up to 20 times the safe level in 22 critically polluted areas of the country. The surface water is the main source of industries for waste disposal. It is found that almost all rivers are polluted in most of the stretches by some industry or the other. Although all industries function under the strict guidelines of the Central Pollution Control Board (CPCB) but still the environmental situation is far from satisfactory. Different norms and guidelines are given for all the industries depending upon their pollution potentials. In India there are sufficient evidences avail-

able related with the mismanagement of industrial wastes. Consequently, at the end of each time period the pollution problem takes menacing concern. The conventional methods so far adopted for the assessment of environmental quality (air, water) have considered only the aspect of direct pollution output. The sectors with high discharge of direct pollution are given uniform treatment under the category of highly polluting sectors. The difference that arises because of indirect effect during the process of production has been completely ignored. Moreover, most of the studies undertaken in the Indian context have been very broad and aggregative in nature. There have been very few attempts to study the industrial pollution at a disaggregated level. So far no clear-cut estimations have been made to determine the overall effects of the industrial pollution, especially industrial water pollution. In very few instances the problem has been identified partially.

Direct pollution effect implies generation of pollution per unit of output in a particular sector. Indirect effects are generated not in an industry in which production takes place directly but in those industries whose output is used as an input in the production process of a particular industry. These effects are important to consider because the overall quality of the environment greatly depends upon the total effects (direct plus indirect). This dissertation presents an analysis of industrial water pollution by way of input-output technique for the period 1983-84 to 1993-94.

The main objectives of the study are–(1) to study the water pollution intensity and thereby to study the nature of inter-relationships among the different sectors of the input-output table of the Indian economy; (2) to examine the nature of technical change and its consequence on pollution generation over a period of time; and (3) to examine the status of pollution control through different abatement techniques. The term pollution intensity has been used to indicate the total (direct plus indirect) generation of pollution. The pollution intensity intends to explain units of the physical pollution output expressed in money value of economic sectors. Thus, these units indicate generation of pollution in cu.m./tons per lakh rupees of output.

For the above mentioned objectives *open, static Leontief* type input-output model is applied. Input-output model is essentially a simplified model of production, which takes into account the interdependencies among producing sectors of the economy. The output of a particular sector depends upon two things - firstly, the amount of quantity demanded by the consumers or households, and secondly, the input requirements of the other sectors of the economy using the output of that sector as an input. Generation of pollution is a regular feature of the production and consumption process and thus, can be referred as an undesirable by-product of the activities. The level of pollution directly varies with the level of output. Any change in the output level of pollutants is the result of either a change in the final demand of specific goods and services or changes in the technological structure of one or more sectors of the economy, or a change in the combination of these two factors. For the present purpose $I - O$ model of the generalized nature has been considered, where extra rows and columns are used to represent the generation and abatement of pollution. The models of the Leontief (1970) and Leontief and Ford (1972) are of this kind. The technological effects have been studied by using the Carter (1970) and Forssell (1988)'s approach.

Empirically, very little use has been made of $I - O$ technique to study the industrial pollution. In most of the empirical literature energy-based emissions have been studied. Gay and Proops (1993), Hawdon (1995), Proops (1996), Wier (1998), Ostblom (1998), have concentrated their work on the factors associated with energy emissions. There have been very few attempts to study the cumulative pollution intensities. Though the studies of Leontief and Ford (1972) for the USA, Miernyk and Sears (1974) for West Virginia USA; James et al. (1978) for Netherlands; Forsund and Strom (1974) for Norway, have made such attempts. But most of these studies have been conducted for the air pollutants. No such attempts have been made on water pollutants. In India too there are very few descriptions and studies available for industrial water pollutants. Murthy, Panda, Parikh (1997a, 1997b) have made some attempts and applied $I - O$ technique for the analysis of the consequences of economic development on carbon-dioxide emissions.

The data utilized in the present study is provided by the Central Statistical Organization (CSO) in the form of Input-Output Transaction Table (IOTT) for the years 1983-84, 1989-90 and 1993-94. These tables can best be described as *open, static Leontief* type tables. The *commodity – by – commodity* input-output tables have been used for the present purpose. In order to make all tables consistent with each other for comparison, these tables have been converted to the common base at 1993-94 prices. Center for Monitoring Indian Economy (CMIE 1989, 1991, 1993, 1994) price indices and National Accounts Statistics (NAS) figures have been used for this purpose. Another adjustment is done in terms of number of sectors; original 115 sectors of the IOTT have been condensed to 56. These sectors are formed on the basis of their environmental consequences and also on economic rationale. The final demand category has five components–private final consumption expenditure (PFCE), government final consumption expenditure (GFCE), gross investments (GI), exports (EXP) and imports (IMP).

The other data used in the study for the creation of environment matrix has been collected from various secondary sources. However, the main sources have been Central Pollution Control Board (CPCB) and Uttar Pradesh State Pollution Control Board (SPCB). The environment matrix has been formed for 36 different organic, inorganic and toxic water pollutants. Thus, the analysis has been performed for 56 sectors with 36 water pollution parameters. There are three categories of industries found, viz. non-polluting, highly polluting and low/moderately polluting. Out of 56 sectors 6 sectors appear to be non-polluting, 26 sectors are highly polluting and remaining sectors are low/moderately polluting.

In the first instance we have analyzed the direct pollution intensity. The analysis shows that most of the direct pollution is generated by the sectors of the highly polluting category. Other moderately or low-polluting sectors are responsible for only small proportion of pollution generation. Sectors such as, dairy, beverages, textile, paper, leather, rubber, heavy chemicals, fertilizers, drugs, synthetic fiber etc, are responsible for most of the pollution in the economy.

The analysis on total (direct plus indirect) water pollution intensity has been performed from two perspectives– firstly, the interaction effect of all the sectors has been calculated by taking the direct pollution coefficients of all the sectors at a time and secondly, separate analysis has also been performed for highly polluting sectors. This has been done by taking the pollution coefficients of highly polluting sectors only and assuming pollution from other (low/moderately-polluting sectors) sectors to be zero.

The results regarding total (direct plus indirect) water pollution intensity have also confirmed the previous results obtained in the case of direct pollution intensity. Again highly polluting sectors appear to be major polluting sectors. Three important categories of sectors have clearly emerged from this analysis. Firstly, sectors in which there is high direct and high indirect effect. Secondly, sectors in which there is high direct effect but indirect effect is not very significant. Thirdly, there are sectors in which direct pollution intensity is very low but the indirect intensity component is very high. All these categories are cause of concern. The uniqueness of the input-output technique is in finding the third category.

The total water pollution intensity results of highly polluting sectors indicate that not much difference is observed after eliminating the direct pollution effect of low/moderately polluting sectors. This shows that most of the pollution in the economy is generated by the inter-relatedness of the highly polluting sectors. If pollution of highly polluting sectors can be possibly controlled then the overall situation of the rising industrial effluents can also be controlled to an extent.

The final demand intensity has also been analyzed in order to find the contribution of each component of final demand category in total pollution generation. If we divide the entire final demand category into three parts viz., consumption (private plus government), investments and exports then we find that major portion is held by the consumption category in which private final consumption expenditure (PFCE) appear to be most dominant.

The next objective is to study the effect of technological change on pollution generation. The production function approach of the input-output technique has been followed for the assessment of technological change on pollution generation. The analysis has been done by taking the structural coefficient matrices at two different time periods and final demand vector is kept constant at the base period. The level of pollution is then compared from two different structural coefficient matrices. This analysis has been performed at aggregated as well as at disaggregated level for 36 water pollution parameters of the 56 sectors of the $I - O$ table. For the purpose of analysis the entire period has been divided into two sub-periods viz. 1983-84 to 1989-90 and 1989-90 to 1993-94. Separate analysis covering entire period from 1983-84 to 1993-94 has also been done.

It is found that over a period of time the input technology has not been environment friendly. Even in highly polluting sectors the pollution growth has been very high. The technology deterioration in terms of environmental pollution is more prominent during the first sub-period. During second sub-period some improvement has been observed. The analysis covering entire period again indicates deterioration in technology over a period of time. During 1983-84 to 1989-90 agriculture, other services, construction, dairy, sugar, edible oil, food products, beverages, tobacco, textile, jute, leather, rubber, plastic, fertilizers, paints and varnishes, drugs and medicines, other chemicals, synthetic fiber and batteries have shown highest growth in pollution output as a result of technological change.

During the second sub-period many industries under the highly polluting industrial category have given sign of improvement with 1993-94 technology in comparison to 1989-90 technology. The industries that have been present with high positive growth of pollution have now started showing negative trend for the majority of the pollutants. Industries such as, sugar, food products, beverages, plastic, fertilizer, drugs and medicine, are important among them. The most drastic change is being observed in case of other services, and construction.

The results covering entire period from 1983-84 to 1993-94 are very much similar to the results of the first sub-period i.e. 1983-84 to 1989-90. Again pollution growth in most of the highly polluting sectors has been on rise. No gains of technological change have been observed on the pattern of pollution generation.

The next objective is to analyze the pollution control status in the economy. For this purpose data on three abatement techniques has been collected. The first two techniques show secondary level pollution abatement and third technique reflects the level of abatement when tertiary level treatment is undertaken. The actual data on three abatement techniques could be obtained only for 12 sectors and 5 water pollution parameters. With this level of pollution is calculated from three alternative abatement techniques and their efficiency of pollution abatement is calculated. Two exercises have been performed– firstly, the difference in pollution abatement from three different abatement techniques is calculated and their efficiency is compared in terms of pollution abatement. Secondly, the status of pollution abatement is being examined by comparing the actual pollution intensity with the pollution intensity of the three abatement techniques.

The result shows that third abatement technique is at least 8-10 % more efficient in the case of biological and chemical oxygen demand (BOD and COD), in comparison to first and second technique. This implies that if it is possible to employ the tertiary level effluent treatment in some of the sectors then pollution can be reduced to a great extent. The actual pollution intensity is several times greater than the pollution intensity of three abatement techniques. The overall situation of pollution abatement in the economy is not very satisfactory.

The findings of the present study can be useful for the formulation of the environmental policy and design of the production system. This gives an idea to the policy makers about the water pollution consequences of the past and provides a basis for the future policy at aggregated as well as disaggregated level.

Dedicated

to

My Parents

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Contents

List of Tables

Appendices

Chapter 1

Introduction and Nature of the Problem

There are a number of important environmental dimensions to development. In the last few decades, the Indian economy has confronted both population explosion and an accelerated growth of industries. Consequently, problems of high pollution output and over-utilization of natural resources have continuously emerged over a period of time. The environmental problems in India have two basic features– firstly, problems that arise because of adverse developmental process and secondly, the problems that result from poverty and under-development. The environmental implications related with developmental effects are immense and have direct links with other environmental problems. The pollution generated by the industrial activities is the one among them that is causing menacing concern. It is therefore being addressed in this study.

The effects of the various industrial and other developmental projects have pressing consequences on environment. The poorly planned industrial processes have been usually environmentally destructive. Moreover, pollutants generated by the industrial sector have contributed substantially, both towards air, land and water pollution. Consequently, over a period of time the quality of land, air and water has distinctively degraded. The rapid industrialization accompanied by the high rate of urbanization has

put increasingly demand pressure on the nation's common property resources, such as air and water. Conversely, the real threat to development comes from the degradation of natural resources, in the form of drought, floods, heavy rains or no rains in the various parts of the country. Air and water pollution combined with the mismanagement of the solid waste, have resulted in severe damage to the natural resources and thereby a damage to the quality of life. The growing pollution in our watercourses is a cause of concern. The pollution generated by the industrial effluents has been an important cause for the degradation of the quality of streams in these watercourses. Almost all the major rivers in most of the stretches are polluted by the one or more industries or urban habitats. Thus, the developmental process confronts the fundamental dilemma that is, on the one hand it enriches the society through wealth creation in many forms and on the other it depletes the natural resources, hampers the quality of life and future of economic growth. The need of the hour is to incorporate the environmental issues into the economic decision making. Over the last few decades these environmental parameters have been lagging behind the economic parameters (or gains). Consequently, industries have shown un sustainable patterns of resource exploitation.

The next section focuses on the state of industrial pollution in India, followed by a section on formulation of problem and objectives of the current study. The last section provides a sketch of the organization of this study.

1.1 Industrial Pollution in India

he activities that cause pollution are many. All economic activities of production and consumption are associated with the generation of some amount of pollution. Only the degree and the magnitude vary with the type of economic activity chosen. Generally most of the activities involve burning of fossil fuels and large amount of water consumption either for industrial processing or for transport and trade. Besides, domestic activities of consumption involve burning of bio-fuels. All these factors create

environmental hazards and poses serious threat to all communities. Out of these categories pollution generated by industrial sector contribute substantially, both in air and water. In the recent past industrial sector has increased to a fair extent that has important environmental implications. Table 1.1 shows the growth of different categories of industry during the past several years.

Table 1.1: **Growth of Indian Industries**

S.No.	Year→ Eco.Activities↓	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94
1	Manufacturing	98379	99724	103373	105511	107454	113890	116227
2	Electricity,Gas & water supply	458	481	493	518	505	961	542
3	Repair service & cold storage	3759	3872	4126	4150	4327	4643	4825
Total	All Activities	102596	104077	107992	110179	112286	119494	12159

Source: Compendium on Environmental Statistics, 1997

As the number of industries and their size increases, it has an important implication on environment because the industries discharge effluents, solid wastes, particulates and other hazardous wastes of different variety. As a result ambient air and water quality are affected. Although all industries operate under the strict guidelines and standards prescribed by the State and Central Pollution Control Board (CPCB), we do observe increasing pollution generation by them.

The ambient air and water qualities in India are continuously deteriorating and consequently the environmental quality is far lower as compared to the international standards. It is pertinent to note here that even if all industries fulfill the prescribed norms, the ambient air and water quality will still deteriorate because of the increase in the number of industries and apart from other reasons like urbanization, population pressure, poor technology and lack of proper management of natural resources. The other reason for the deterioration of the environmental quality in India is that standards have not been revised since they were enacted, with the exception of automotive exhaust.

For the purpose of regulation and monitoring, Central Pollution Control Board (CPCB) has identified 17 highly polluting[1] industries. These industries operate under the strict guidelines of the CPCB. To assess the quality of environment, CPCB in India had carried out a countrywide survey in 1995. In this survey 8432 large and medium[2] industrial units were identified for the assessment. Out of these industrial units 2443 units were found to be large and 4280 units were identified as medium. Table 1.2 shows the category wise distribution of these industries.

Table 1.2: **Category wise Distribution of Large and Medium Scale Units**

S.No	Category	No. of units
1	Cement	253
2	Caustic soda	13
3	Dairy	127
4	Distillery	218
5	Fertilizer	108
6	Food stuff	353
7	General engineering	851
8	Iron and steel	237
9	Inorganic chemicals	442
10	Mining	77
11	Man made fiber	16
12	Oil drilling	10
13	Paper	279
14	Pesticides	70
15	Petrochemical	67
16	Pharmaceutical	256
17	Refinery	26
18	Rubber products	118
19	Sugar	393
20	Tannery	85
21	Textile	559
22	Thermal power	87
23	Others	3787
	Total	8432

Source: Central Pollution Control Board, CPCB PROBES/69/1997-98.

Out of the above industrial units CPCB found 1549 industrial units to be under 17 highly polluting industrial category. In this survey only two or three industrial

[1] Aluminium, caustic soda, cement, copper, distillery, dyes, and dye intermediates, fertilizer, iron and steel, leather, pesticides, petrochemicals, pulp and paper, refinery, sugar, thermal power plants, Zinc– industrial categories are under highly polluting industries.

[2] Those having a capital investment exceeding 2 crores are large and between 65 lakhs and two crores are medium scale unit.

categories were found with 100 percent units complying pollution standards. Only seven industrial categories were having 80-90 percent compliance and in rest of the categories the compliance status was found between 60-70 percent. Overall, around 80 percent of the units were complying with the CPCB norms. Table 1.3 presents the compliance status of different industrial units.

Table 1.3: **Compliance Status of Highly Polluting Sectors**

S.No.	Industrial Category	Total Number of Units	Number of Units having Compliance
1	Aluminium	7	5
2	Caustic soda	25	25
3	Cement	116	103
4	Copper	2	0
5	Distillery	177	117
6	Dyes and dye intermediate	64	55
7	Fertilizer	110	97
8	Iron and steel	8	2
9	Leather	70	59
10	Pesticides	71	63
11	Petrochemicals	49	49
12	Pharmaceuticals	251	224
13	Pulp and paper	96	62
14	Refinery	12	10
15	Sugar	392	296
16	Thermal power plants	97	65
17	Zinc	4	4
	Total	1549	1236

Source:TERI Energy Data Directory and Yearbook 1997/1998.

It is found that the thermal power and fertilizer industries are the consistent defaulters in meeting air quality emission standards while sugar and paper-pulp industries are major defaulters in meeting the standards of industrial liquid effluents. The following section explains the state of air and water pollution in India.

1.1.1 Air Pollution

The problems related to air pollution continue to harm both rural as well as urban population. The factors responsible for the increase in urban air pollution in India have been higher growth in power consumption, industrialization and vehicle use. A World

Bank report brought out in 1996 states that more than 40,000 people die prematurely every year in India because of air pollution. According to India Development report (1999-2000) six of the ten largest cities in India — Mumbai, Calcutta, Delhi, Ahmedabad, Kanpur and Nagpur— have severe air pollution problem with annual average levels of suspended particulate matter (SPM) to be at least three to five times higher than the WHO standards. Delhi is the fourth top polluted city in the world. Vehicular emission in India accounts for the 70% of the total air pollution in India. The emissions of the CO, NO_x, unburned hydrocarbons and particulate are causing serious concern. India Development Report reveals that the transport sector contributes for 27% NO_2, 74% CO, 11%VOC, and 100% lead in urban areas. According to CPCB survey (1989) on vehicular pollution, the total emission of particulate matter, sulfur dioxide, oxides of nitrogen, carbon and hydrocarbons in Delhi was around 872 tons per day. In urban sectors the major proportion of environmental pollution is due to suspended particulate matter (SPM), which is found to be beyond the permissible limit at some places in India.

The emission from industries varies as they carry out wide range of industrial processes. The important pollutants from industries are SPM, CO, SO_2, and NO_x. Thermal power plants are the major contributors to SPM emission. The concentration of these pollutants is increasing, as industries are unable to comply with the prescribed standards. These standards include permissible limits for SPM and in few cases SO_2 where it is the prime pollutant. But no standards for NO_x and CO have been prescribed. Industries do not have the requisite control devices either because of cost considerations or due to lack of monitoring on behalf of the government.

To ensure the air quality status in India CPCB in its survey found that only 5 industrial categories as having adequate Emission Control System (ECS). The industrial categories with more than 60% units having requisite Emission Control System are presented in Table 1.4.

In a survey conducted by CPCB it was found that out of 8432 large and medium

Table 1.4: **Status of Emission Control System (ECS) in Air Polluting Industries**

S.No.	Category	Percentage of Industries with ECS
1	Caustic soda	92
2	Pesticides	87
3	Fertilizers	72
4	Pharmaceuticals	71
5	Cement	60

Source: Central Pollution Control Board, CPCB PROBES/69/1997-98.

industries, 6086 (72%) have installed ECS. These include 4854 units having adequate and operating Systems while in 1232 ECS was not adequate. In 2346 units either no ECS was installed or it was non-operational or it was not required. According to the CII environmental report (1995) major air polluting industries have registered an average growth of 3.5-13% in the last decade, with 3.5% growth in fertilizer and pharmaceuticals and 13% growth in chemical industry. Other industries such as petrochemical, cement, mining, thermal power, iron and steel etc. have followed the trend between 7-8%. In another observation, CPCB identified 15% industries as air polluting, 77% as water polluting and 8% as both air and water polluting.

The CPCB has been regularly monitoring ambient air quality at over 290 locations spread in 92 cities/towns. Since 1994 MoEF has prescribed 24 hourly standards for three distinct areas viz. industrial, residential (rural and other areas), and sensitive. A study in 1995 estimated the economic loss due to air pollution alone in 36 cities of India at $2102 million/year and consequent premature deaths at 40351/year. Major environmental costs from all sources have been estimated to be $9715 million/year in India amounting to 4.53% of GDP (MoEF, 1999).

1.1.2 Water Pollution

The factors responsible for deteriorating water quality in India have been rapid industrialization, population growth and intensive agriculture. They have generated problems related to contamination of water with human and industrial wastes, effluents, agricultural run-offs etc. This wastewater either permeates into the ground or finds its way into the surface watercourses. As a result the water quality of the surface and underground water falls below the standard level. The problem is worst where river passes through large cities or areas having industrial establishments.

It is found that one-third of the total water pollution comes in the form of effluent discharge, solid wastes and other hazardous wastes. Untreated or allegedly treated effluents have increased the level of toxins in water, like cyanide and chromium up to 20 times the safe level in 22 critically polluted areas of the country. In addition to this, six of the 20 major river basins in India suffer from water scarcity, both quantitatively and qualitatively,(MoEF, 1999). The quality of underground water is also affected because of the intrusion of polluted water. The water quality monitoring results indicate that organic and bacterial pollution are most pre-dominant in the aquatic resources.

Domestic and municipal wastewater is also a cause of concern. Seventy five percent of the total wastewater generation comprises of domestic and municipal effluents. Very few cities in India have proper sewage treatment plants. Even the major cities in India, like Mumbai and Calcutta do not have the capacity to treat their full sewage and sludge. Only 20% of the total waste water is treated in class-I cities and in class-II cities only 2% (India Development Report, 1999-2000). It is found that in some instances, the polluted water gets mixed with fresh drinking water supply, and causes several severe water-born diseases. In a survey conducted by CPCB it was found that 90% of the water is polluted in 241 class-II towns in India. It was also found that water problems are severe in small towns.

The major cause to water pollution comes in the form of industrial effluents and wastes. The surface water is the main source for industries to dispose off their wastes.

Industrial effluents have no specific composition of wastes. Whatever is not consumed in the process of production is carelessly dumped into the water streams. Almost all the rivers in most of the stretches are polluted by one or more industries. The water quality of most of the rivers, so deteriorated that it is not fit for the utilization of the human beings. In a CPCB survey of 8432 industrial units, not even a single industrial category was found with 100% units having requisite effluent treatment plants. More than 50% of the units in the categories of distillery, pulp and paper, textile, iron and steel are yet to attain satisfactory performance level with regard to installation and operation of Effluent Treatment Plants (ETP). Out of 8432 large and medium industries, only 4989 (59%) have adequate and operational ETP. In 1233 units treatment facility was found to be inadequate and in 2210 units effluent is either not treated at all or the ETP is non-operational or the treatment is not required. The status of effluent treatment in different industrial categories is given in table 1.5.

Table 1.5: **Status of Effluent Treatment Plants (ETP) in Polluting Industries**

S.No.	Category	Percentage of industries with ETP
1	Caustic soda	92
2	Pharmaceuticals	80
3	Man made fiber	75
4	Sugar	74
5	Pesticides	73
6	Thermal power	70
7	Fertilizer	69
8	Dairy	69
9	Rubber products	64
10	Food stuff	62
11	Tannery	62

Source: Central Pollution Control Board, CPCB PROBES/69/1997-98.

It was found in the survey, that recently with the improved environmental legislation and strict enforcement of the various laws, the status of pollution control in industries has improved. A comparative study of 1984 and 1995 reveals that the large and medium scale units with ETP provision have increased from 51% to 74%. Table 1.6 presents the comparative picture for the two years.

Table 1.6: **Status of Effluent Treatment Plants (ETP) in 1984 and 1995**

	December 1984	May 1995
Total number of units	4054	8432
Number of units with ETP	2076	6222

Source: Central Pollution Control Board, CPCB PROBES/69/1997-98.

These results of the survey provide some hope for the control of pollution but the situation has not improved much in past several years. As has already been mentioned that in the past few years industries have increased both in size and number to an extent, the state of environment still remains a cause of major concern.

1.1.3 Hazardous Waste Generation in India

Open dumping of wastes and unsafe disposal of collected wastes are the common practices, which is causing growing concern in India. It is predicted that the volume of toxic heavy metals generated in India will be equivalent to the volume of toxic of highly industrialized countries like, USA, UK, and France, within the next 15 years. Of the 4054 large and medium industrial units that were in operation in 1984, about 1422 units were identified as having hazardous waste generation potential based on the notified categories of hazardous waste (CII, 1995). In 1985, the National Productivity Council (NPC) estimated the quantity of hazardous pollution for some industrial categories. Table 1.7 shows the quantity of hazardous waste discharged by some of those industrial categories.

Table 1.7: **Hazardous Waste Generation in India**

S.No.	Industry Sector	Amount T/year
1	Pesticides	5200
2	Bulk Drugs	39800
3	Dyes	26280
4	Petrochemicals	312000
5	Refineries	14900

The Ministry of Environment and Forest (MoEF) has enacted the Hazardous Wastes (Management and Handling) Rules, 1989, under the Environment Protection Act, 1986. It has brought out a guide for the manufacture, storage, and import of hazardous chemicals in 1989, and set guidelines for the management and handling of hazardous waste in 1991. The manufacture, storage and import of hazardous chemical rules list 434 toxic flammable and explosive chemicals, which require careful regulation. The hazardous waste rules list 18 types of waste categories with its regulatory quantity. The major problem with respect to hazardous waste management in the country is the absence of a systematic assessment of the quantity and the hazard potential of the waste.

Health hazards and accidents have increased because of the inappropriate disposal of the industrial as well as municipal waste. A number of sites are identified by the CPCB where higher levels of toxic metals/ions such as chromium, manganese and cyanide are found in municipal waste sites. The waste products of plastics and synthetic materials take quite a long time for decomposition. The mixing of hazardous material with the water and sunlight in open dumping emit rotten smell and poisonous gases, which is the source of major air pollution. Sometimes these hazardous materials get mixed with the water supply in the form of either intrusion of wastewater or with surface water. This causes several water-born diseases. The degradation of environmental quality due to open dumping of hazardous waste material is a serious cause of concern. These untreated pollutants ferment slowly and emit bio-gas that has 65-75% methane content. Methane is a green house gas with global warming potentials (34 times more than that of CO_2). The development of suitable technologies for the waste minimization, disposal and utilization is therefore essential to minimize adverse health and environmental consequences.

1.2 The Nature of the Problem

It is clear from the above description that industrial activities affect the quality of environmental resources in many forms. Most important of all, it affects the natural flow of resources, by introducing the novel substances into the environment. Some of these substances are toxic in nature. These toxic elements also change the physical and chemical composition of natural resources. As a result, an overall degradation of natural resources take place. Thus, any serious effort to curb the pollutants or halt the processes of environmental degradation must involve the formidable task of transforming the industrial practices. At the same time it is also important to assess the magnitude of pollution generation by various industrial activities. The problems related with industrial effluents are taking menacing concern. We have seen that the majority of the industries in our country are water polluting. Although in the recent past with the improved legislations and strict monitoring situation has improved to some extent. Still, it is far from satisfactory and needs attention in various ways. A complete assessment of industrial pollution is needed at a aggregated as well as at a dis-aggregated level. The current study involves inter-industry analysis of industrial water pollution.

The environmental effects so far considered in traditional analysis highlight only the direct pollution aspect. It does not take into account the indirect pollution effects generated during the process of production. This part of the problem is very frequently ignored in the literature of the environmental policy. By direct pollution effect we mean generation of pollution per unit of output in a particular sector. For example if we increase the output of say, paper and pulp industry, direct pollution effect implies that pollution of only paper and pulp sector should be affected. Indirect pollution effects, on the other hand are generated not only in the sector whose output has changed but in other sectors as well that provide inputs to this sector. In the above example, if we increase the output of paper and pulp then not only level of pollution of this sector is affected but also pollution level of other sectors that supply inputs to paper and

pulp sector. There is an inter-dependence found among different producing sectors. In the above example, to produce paper and pulp several inputs are needed, say from agriculture sector, coal, electricity, engineering products etc., and to produce these inputs, further inputs are required from other sectors and so on. In this situation, if we try to increase the level of output of one sector then level of output of other sectors is also affected because other sectors provide inputs to this particular sector. This process of iterations generate series of indirect effects. Since pollution is directly related with the output, the overall magnitude of pollution no longer remains same as that of direct pollution.

Now the whole process can be explained in simple terminology. One industry depends upon other industries for its intermediate product requirement. There is a flow of goods and services from one sector to other sectors of the economy. A sort of interdependence is observed among different producing and consuming units. It is not possible to change the output of even a single sector without affecting the environment. Entire production in the economy is either delivered to the household sector for final consumption or it is utilized in the process of production as input. Magnitude of output depends upon two factors: first, the amount of output that has to be delivered to final consumers and secondly, the input requirement of the industries determined by their technological structure. Any change in final demand or a change in technological structure brings a corresponding change in the level of output. Technology in input-output is depicted by the structural coefficients. Structural coefficients explain how much inputs are needed from different sectors to produce a single unit of output of a particular sector. In the regular process of production, pollution is an undesirable output or a by-product of these activities. Generation of pollution is as inevitable as the production process itself. Level of pollution directly varies with the level of output. In that sense any change in the output level of pollutants is the result of either a change in the final demand of specific goods and services or changes in the technological structure of one or more sector of the economy, or a change in the combination of these two factors.

Leontief (1970) successfully realized the aspect of indirect pollution generated during the process of production. Input-output technique is an important analytical technique capable in explaining the direct plus indirect effects. Technological effects can also be studied with this technique. Thus, present study is based on the analytical framework of the input-output technique.

1.3 Objectives of the Study

The description of the state of environment in India gives us an idea about the increasing industrial pollution and its mis-management in our country. As already mentioned that existing or available studies on India have highlighted only the aspect of direct pollution. They have completely ignored the indirect pollution generated during the process of production. Moreover, most of the studies undertaken in the Indian context have been very broad and aggregative in nature. There have been very few attempts to study the industrial pollution at a disaggregated level. In a very few instances the problem has been identified partially. So far no clear-cut estimations have been made to determine the overall effects of the industrial pollution, especially industrial water pollution.

The estimates of the pollutants generated out of interdependence among the industries would be very much helpful in formulating the environmental policy of the government. In India while defining the industry specific guidelines government has always considered only the direct generation of pollution output. The effect of indirect pollution is not considered in any of the policy formulations. There is an inherent need for examining the detailed production structure and residual flow generated out of inter-relatedness of the producing and consuming sectors of the economy. This study, hence, highlights this issue.

The present study has been undertaken from several aspects. First of all the purpose of the study has been to analyze the production structure and relate it with

the residual flows. Technology is another important determinant responsible for the much of the industrial pollution. The level of pollution in that sense depends upon the technological structure of the economy. The interdependence between the undesirable pollutants and the production level is explained by the structural coefficients. Altering the mix of technologies in the conventional sector would affect the level of pollution. Thus, technology is an issue that has been studied over a period of time.

Generation of pollution is a normal and inherent part of the production system. Pollutants are not discharged in their original form into the environment. Rather, they are treated at different level. We know that the strategy for abating pollution through technological processes of treatment attempt to neutralize the harmful effects of pollutants. Various technological options or abatement techniques are available for the pollution abatement. The different levels of treatment is done by each of these abatement techniques. On the basis of effluent characteristics and cost considerations, one particular technological process is adopted. In the present study, the levels of abatement from different techniques is calculated and then it is compared with the actual level of pollution in the economy.

The input-output tables for the years 1983-84, 1989-90 and 1993-94 have been used for the present study. The selection of the period is determined by the availability of the data for this period. These tables provide details about the production structure of the economy and can be extended for the analysis of environmental pollution.

The present analysis has been designed in such a way that its findings can be useful for the formulation of the environmental policy and design of the production system. This gives an idea to the policy makers about the water pollution consequences of the past and provides a basis for the future policy. Now the objectives of the present analysis can be listed in the following manner—

1. To study the inter-relation effects among different producing sectors on pollution generation.

2. To examine the pattern of cumulative water pollution intensity in different sectors of the economy.

3. To examine the changes in technology and its effect on the level of pollution.

4. To examine the status of pollution abatement in different sectors of the economy.

1.4 Organization of Chapters

The present study consists of seven chapters. The input-output technique, review of literature and methodology is described in chapter two.

Chapter three explains different sources of the data. 115 sectors of the economy are aggregated into 56 sectors. An environmental matrix has been prepared for 36 water pollutants of the 56 newly formed sectors.

Chapter four is devoted to an empirical analysis. The direct plus indirect water pollution intensity is calculated in this chapter. In chapter five, technological effects on industrial pollutants have been derived, empirically. Chapter six explains the status of pollution abatement in different industrial categories of the input-output table.

Finally in chapter seven summary and conclusions are presented. Limitations of the study are also discussed in this chapter.

Chapter 2

The Input-Output Approach, Review of Literature and Methodology

The purpose of this chapter is to review the background literature, present the input-output approach of economic analysis and outline the methodology for the present study. The chapter is divided into six sections. In the first section, the basic $I-O$ technique has been explained. Section two deals with the input-output studies covering environmental literature. Section three discusses about the environmental literature in India. Choice of technique is discussed in section four, followed by a section on choice of model for the present study. Methodology is discussed in the last section.

2.1 The Input-Output Approach

The input-output approach deals with the analysis of the interdependence of different producing and consuming units in an economy by way of intersectoral models. The origin of these models can be traced back to the Tableau Economique of Quesney

published in 1758, which gave a diagrammatic representation of how expenditures can be traced through an economy in a systematic way. Although the idea was given but the systematic modern approach was developed by Leon Walras in 1877. The Walrasian system explained the interdependence among productive sectors of the economy by means of a set of equations for consumer income and expenditure, production cost in each sector and total demand and supply of commodities and factors of production (see Kuenne, 1954). The idea behind this mathematical formulation was to explain the existence of determinate solution for the quantities and prices in the system under the assumption of maximizing behavior of economic agents.

Walrasian model on the one hand, had very few economic realities to offer and on the other hand was too complicated for empirical verification. As a result the gap between non-operational theory and inadequate empirical research became wider. The Leontief (1936) approach to input-output (I-O) analysis proposed to eliminate this gap [see Leontief (1986)]. The conception of I-O analysis led to the practical solution of the problem created by the general equilibrium theorists. In Leontief's conception statistical data was used in hypothetical production and consumption equations in the form of explicit multi-sectoral producing and consuming units. The systematic input-output approach was applied on American economy after the great depression of 1930s.

Leontief's I-O technique deals with the quantitative analysis of the interdependence among various producing sectors of an economy as well as the final consuming sectors. The information for the development of I-O model is acquired from the inter-industry table, which is a table of I-O transactions for various sectors. In the next section such tables are discussed in some details.

2.1.1 Input-Output Tables and the Fundamental Relationships

The input-output table of an economy traces the flow of goods and services from one productive sector to another, in an accounting period. Under this analysis the

whole economy is decomposed into finer sectors. Each sector in the accounting system appears twice, first as a producer of output and secondly as a user of inputs. This formulation provides the system of interdependence of various sectors of the economy by means of a two-way table. The rows of the table describe the distribution of output among producing sectors as well as the final demand sector. Entries in column register for the composition of intermediate inputs (depicted by the values in row vector)and primary inputs. Primary inputs such as land, labor and capital etc. are primary in the sense that these are determined by factors outside the system and supplied by the value addition sectors. These factors are utilized by the industries in the process of production. Originally the I-O table was constructed in physical terms but to avoid the anomalies associated with different measuring units of the sectors, it is expressed in value terms. The representative structure of the $I - O$ table is given in table 2.1.

As already mentioned the output of a sector is either consumed in the process of production, as an intermediate use, or it is consumed by the final demand category. The distribution of output between intermediate use and final use and between produced and primary inputs distribute the entire transaction in an economy into four quadrants. These distributions are marked in the representative table 2.1.

The first part contains the final use of products and services. The total final use of a product can be decomposed into various categories such as investment, private consumption, government consumption and exports. Major portion of the GNP is absorbed by this final demand quadrant. The sectoral deliveries to final demand are shown as the output of sector i delivered to the k^{th} category of final expenditures, denoted as Y_{ik}.

Second category is the most important part of the inter-industry transactions. As already mentioned each sector in the transaction table appears twice, as a producing and as a purchasing sector. Thus, the resulting matrix would be a square matrix. Each element X_{ij} of this matrix denotes the amount of commodity i used by sector j at constant prices. The total intermediate use of commodity i is depicted by W_i and

Table 2.1: **Inter-Industry Accounting System**

<table>
<tr><td></td><td colspan="2">Purchasing Sectors</td></tr>
<tr><td rowspan="2"></td><td>Intermediate Use</td><td>Final Demand</td></tr>
<tr><td>Sector
1…….j…….n</td><td></td></tr>
<tr><td>Producing Sectors 1 . . . . . . i . . . . . . n
Total Produced Inputs</td><td>QUADRANT II</td><td>QUADRANT I</td></tr>
<tr><td>Primary Inputs
(Value Added)</td><td>QUADRANT III</td><td>QUADRANT IV</td></tr>
<tr><td>Total Production</td><td></td><td></td></tr>
</table>

Source: Chenery & Clark (1965).

U_j records the total purchases from other sectors of the economy.

The third part of the table records for value addition in different sectors. These are the primary inputs in the sense that they are determined outside the system such as land, labor, and capital (in static model). The payment to the primary sector appears as a difference between the value of output and cost of inputs incurred by a sector. In this sense it is produced outside the system. V_j denotes the value addition generated in sector j.

Finally, the fourth part contains the primary factors put into the final use under the categories of government employment and domestic service. Although it does not enter as a regular transaction in inter-industry modeling but important to maintain the consistency in regular $I - O$ table. The last column comprises the total supply of a product equal to domestic production of sector i plus imports of commodity i.

Above-mentioned input-output formulation leads to two balance equations. First, the rows of the $I - O$ table states that the total supply of each commodity is equal to total demand, which can be decomposed into intermediate and final demand. In this way sum total of sector i output denoted by X_j is the sum of the deliveries of the output of sector i to all producing sectors and final users. Thus,

$$Z_i = M_i + X_i = \sum_j X_{ij} + Y_i = W_i + Y_i \tag{2.1}$$

Where Z_i in equation (2.1) is the total supply of commodity i, M_i import of commodity i and Y_i the final demand for commodity i. The second equation is derived from the column entries of the transaction matrix and describes the input structure of various sectors. The total production in each sector is equal to the value of inputs purchased from other sectors plus value added in that sector.

$$X_j = \sum X_{ij} + V_j = U_j + V_j \ (j = 1 \ldots n) \tag{2.2}$$

Where V_j in equation (2.2) is the total use of primary inputs in sector j and U_j is the total use by sector j of inputs purchased from other industries $(\sum_i X_{ij})$.

In this way final demand vector appears to be a difference between the total production and intermediate use of the product and value added becomes the difference between the total value and payments for inputs purchased from rest of the sectors. We can write—

$$\sum X_{ij} + Y_i \;=\; \sum X_{ij} + V_j \tag{2.3}$$

This relation also holds for the sum total of all the intermediate products, considering all sectors at a time.

$$\sum_{i=1}^{n}\sum_{j=1}^{n} X_{ij} + \sum_{i=1}^{n}\sum_{k=1}^{n} Y_{ik} \;=\; \sum_{j=1}^{n}\sum_{i=1}^{n} X_{ij} + \sum_{j=1}^{n} V_j \tag{2.4}$$

It follows from equation (2.3) that the sum of value added is equal to the sum of all deliveries to final users. That is,

$$\sum_{j=1}^{n} V_j \;=\; \sum_{i=1}^{n}\sum_{k=1}^{m} Y_{ik} \tag{2.5}$$

This is the most important result of the I-O technique. With the above formulation the relationship between input-output accounts and the national income aggregates could also be established.

2.1.2 Assumptions of the Input-Output Technique

Input-output analysis is an important analytical tool for the analysis of the performance of production, consumption, and investment, in an economy. $I-O$ models are the basis for any such analysis of the producing or consuming units. However, the working of the input-output model requires that real system be translated into analytical reasoning. For this certain assumptions are taken, which are as follows—

The basic idea underlying the input output technique is the possibility of dividing all productive activities in an economy into sectors, whose interdependency can be easily explained by the simple input functions. These sectors are divided in such

a way that a single production function is assumed for each sector. Under this assumption, each industry produces a single homogeneous output. These industries are defined in terms of a commodity or a group of commodities. Hence, industry producing homogeneous products employ unique and fixed technique of production.

The second important assumption is that the quantity of each input, used in production by a sector is determined entirely by the level of output of that sector. In this way each industry uses a fixed input ratio for the production of its output. This implies that the production in each industry is subject to constant returns to scale, so that a $k - fold$ change in every input will result in an exactly $k - fold$ change in output. There is no substitution among inputs in a given production process.

The third assumption is the fulfillment of Hawkins-Simon condition (Hawkins and Simon, 1949). This states that the total output X_i of sector i must be adequate enough to meet the intermediate and final demand of that sector.

Additionally it is also assumed that there are no externalities present in the process of production. The sum of inputs used in the production of several commodities is the same as the sum of inputs used in the production of each separate commodity.

At a glance these assumptions may seem to be very rigid and unrealistic, but without them formulation of the model would have been just impossible. Therefore, success of the input output technique is not on the basis of these assumptions, rather it depends upon the accuracy of the results offered by the technique.

2.1.3 Basic Input-Output Model

The input-output model is designed for the analysis of the production process of different sectors of the economy. These production processes in its turn are governed by the technological characteristics of the economy. With the above set of assumptions it is possible to write the technical coefficient matrix. This matrix would exhibit the technology of the productive system. Each element of the technical matrix shows the

amount of each input required in the process of production.

Now it is possible to write an equation for demand X_{ij} of each industry j for each commodity i as a function of its own level of output X_j.

$$X_{ij} = \bar{X}_{ij} + a_{ij}X_j \tag{2.6}$$

Where a_{ij} in equation (2.6) is the input coefficient. The first term indicates any fixed cost element, which do not vary with the level of production. If the first term is zero, then only second term appears in the demand function. If it is not zero then it becomes the part of final demand and only second term appears. In order to produce each unit of the j^{th} commodity, the input need for the i^{th} commodity must be a fixed amount denoted by a_{ij}. Thus,

$$a_{ij} = \frac{X_{ij}}{X_j} \tag{2.7}$$

Specifically, relationship in equation (2.7) indicates that the production of each unit of the j^{th} commodity will require a_{1j} amount of the first commodity, a_{2j} of the second commodity and a_{nj} of the n^{th} commodity.

For an $n-economy$, the input coefficients can be arranged into a matrix $A = [a_{ij}]$, in which each column specifies the input requirements for the production of the one unit of the output of a particular industry. Now the technical coefficient matrix $[A]$, can be written as—

input	output				
	1	2	3	...	n
1	a_{11}	a_{12}	a_{13}	...	a_{1n}
2	a_{21}	a_{22}	a_{23}	...	a_{2n}
3	a_{31}	a_{32}	a_{33}	...	a_{3n}
⋮	⋮	⋮	⋮		⋮
n	a_{n1}	a_{n2}	a_{n3}	...	a_{nn}

As already mentioned the total output of a sector is composed into two parts–intermediate demand and final demand. By 'intermediate demand', we mean the use

of the commodity to produce other commodities, and by 'final demand' is the amount that is used for non-productive purposes, such as consumption, stock building, export etc. Now the demand function for n industries can be written as—

$$\begin{aligned} X_1 &= X_{11} + X_{12} + \cdots + X_{in} + F_1 \\ X_2 &= X_{21} + X_{22} + \cdots + X_{2n} + F_2 \\ \\ X_n &= X_{n1} + X_{n2} + \cdots + X_{mn} + F_n \end{aligned} \tag{2.8}$$

From equation (2.7) we can substitute the corresponding values of $a_{ij}X_j$ in equation (2.8). Thus,

$$\begin{aligned} X_1 &= a_{11}X_1 + a_{12}X_2 + \cdots + a_{1n}X_n \\ X_2 &= a_{21}X_1 + a_{22}X_2 + \cdots + a_{2n}X_n \\ \\ X_n &= a_{n1}X_1 + a_{n2}X_2 + \cdots + a_{mn}X_n \end{aligned} \tag{2.9}$$

$$X = AX + F \tag{2.10}$$

where $X = (n \times 1)$ vector of gross output; $A = n \times n$ matrix of technical coefficients; $F = n \times 1$ vector of final demand.

By solving equation (2.10) we get,

$$X = (I - A)^{-1}F \tag{2.11}$$

or

$$X = BF \tag{2.12}$$

where, $B = (I - A)^{-1}$

Equation (2.12) establishes the relationship between the final demand and total output. This equation can be used to determine the level of gross output which are

required to meet the demands for a given bill of final goods and also captures a change which is required to support all the producing activities involved in providing these final goods. The inverse matrix $(I - A)^{-1}$ of equation (2.11), popularly known as '*Leontief inverse*', calculates the direct and indirect demand of industry i generated by a unit of final demand of industry j. Any change in the bill of final demand brings a simultaneous change in all the producing sectors of the economy. '*Leontief inverse*' attempts to calculate all those changes in an economy. This inverse can also be used to calculate the effect on primary inputs such as labor and employment. Recently, it has been applied in the diversified areas for the analysis of total change in an economy. Other extensions to the Leontief inverse will be given at the places wherever the need arises.

2.2 Environmental Studies Under the Input-Output Framework

The inter-relations between the economic and ecological system generate the flow of inputs and outputs in many forms. The economic resources are drawn from the environment and the residual wastes are discharged back to the environment [see Muller, (1979)]. In this way, there is a physical flow of materials between these two. Generation of waste is a normal and inherent part of the production and consumption process. Ayres and Kneese (1969) consider them as externalities which provide dis-services to the producers as well as consumers. Various environmental media such as air, water, etc. have been used for the discharge of these unwanted residuals.

The flow of materials within producing as well as final consuming units can very well be traced both in terms of value and physical units. However, the material flow from and back to the environment is seldomly reflected completely, neither in value nor in physical terms. The inter-industry flow models provide a very much convincing tool for studying these interactions and also for projecting future residual production.

In recent years considerable attention has been given to the extension of the Leontief input-output (I-O) table. Such extensions mainly capture the factors associated with inter-industry transactions in the economy. Environment being a focal point of all activities has been very well studied under these inter-industry transactions.

Pioneered by Cumberland (1966), Daly (1968), Isard (1968), Ayres and Kneese (1969), and Leontief (1970), there now exist a substantial literature, more than ever, incorporating the environmental factors in an I-O system[1] Cumberland (1966) introduces three extra rows to the flow matrix. The first one of which represented monetary estimates of environmental benefits incurred by individual economic sectors; the second comprised of preventive cost of environmental deterioration and the third described the 'environmental balance' measured as the difference between the relevant benefits and costs. Cumberland's model proved to be highly impractical in view of the inherent limitations and restrictions.

Daly (1968) tried to integrate economic sectors with that of environmental sectors. His model gives a good description of the entire system but is not very suitable for analytical purposes.

Isard et al.(1968) examined the linkages between the social and ecological system by using the $commodity - by - industry$ set of accounts. An $I - O$ model was extended to cover various ecological products. Isard's hypothesis was built on the premises that not only social sectors import inputs from the ecological sector but also that social sectors export output to the ecological sector. In this sense one system's imports and exports are other system's exports and imports, respectively. In this way economic and ecological systems are linked with each other. On the basis of cost-benefit analysis, the model is used to evaluate the different proposals and policy alternatives. Isard's model is also not applicable for practical purposes because it is difficult to assign values to environmental sectors.

Ayres and Kneese (1969) argued that the externalities associated with production

[1] see Forssell and Polenske, 1998 for brief review of environmental input-output models.

and consumption in the form of waste residual need seperate treatment. It is because there are certain classes of physical exchange for which there exist no economic transaction. Certain environmental inputs of the common property resources are tacitly utilized in the process of production, such as, private use of air, streams, lakes and ocean in the form of inputs; and the assimilative capacity of the environment to dispose the waste residuals. Thus, there is a physical flow of unwanted material inputs in the form of diluent and pollutants to the productive sector. In contrast to the services of the environment it purely render dis-services that flow to consumers as well as producers, irrespective of their usefulness. Ayres and Kneese advocated that the common failure to recognize these effects poses problem in the fundamental law of conservation of mass[2]. With a set of formal mathematical framework, it has been shown that the mass of all inputs into a system are equal to the mass of all output. The conceptual work by Ayres and Kneese was improved by Victor (1972). An empirical attempt was also made in Victor's analysis for environmental planning.

Although, certain aspects of the problem were made familiar but the systematic approach to environment under $I-O$ framework stems from the two seminal articles by Leontief (1970, 1974) and Leontief and Ford (1972). Later, Miller and Blaire (1985) classify the environmental $I-O$ models into three categories—

1. Input-Output models of the generalized nature, where extra rows and columns are introduced to represent the generation and abatement of pollutants, respectively, [Leontief (1970) and Leontief and Ford (1972)].

2. Economic-Ecologic models incorporating ecological commodities that are inputs into or residuals from production and consumption processes. The basic $I-O$ system is augmented by ecosystem sub-matrices that allow for flows within and between economic and ecological sectors rather like the flows in an inter-regional $I-O$ model, [Isard et al.(1968), Daly(1968), James et al.(1978)].

[2]This law states that assuming no accumulation the mass of all inputs into a system must equal the mass of all outputs.

3. Commodity by industry models where additional rows and columns are introduced to represent the ecological inputs and outputs, respectively, [Victor (1972)].

Because of the exhaustive data requirement involved with economic-ecological models and commodity-by-industry models, most empiricist apply the generalized $I-O$ models of the Leontief type [(Kohn (1975), also Cumberland and Stram (1976) and Herendeen (1998)]. Flick (1973), Steenge (1978), Lowe (1979), Lee (1982), Rhee and Miranowski (1984), Qayum (1981), Arrous (1984), Luptacik and Bohm (1994, 1995), and many others followed the Leontief framework and tried to reformulate the model in many ways. The Leontief's input-output model has a wide scope for empirical analysis. The following section discusses about the reformulations and extensios of the Leontief model, then follwed by a section on empirical studies.

2.2.1 Leontief's Model of Environmental Repercussions

As already mentioned the $I-O$ table traces the level of output of each sector of a given national economy in terms of its relationship to the corresponding level of activities in all the other sectors. The output of a particular sector depends upon two things— first, the amount of quantity demanded by the consumers or households, and secondly, the input requirement of the other sectors of the economy using the output of that sector as an input. Generation of pollution is a normal and inherent part of the regular production and consumption process. The level of pollution depends upon the technological structure of the economy. Technological characteristics are explained by the structural coefficients of the conventional sectors. In order to determine the environmental repercussions these structural coefficients have been incorporated in the regular $I-O$ table of the economy.

Leontief contributed basic environmental $I-O$ model in two ways. Firstly, he introduced explicitly the involuntary by-products (pollutants) of the regular production and consumption activities, and combined them with the output coefficients of conven-

tional sectors of the economy. Secondly, anti-pollution sectors were combined with the conventional sectors and the pollutants of the conventional sectors were suppose to be treated in this anti-pollution sector. In this way, the amount of emitted pollutants was endogenized. The basic $I-O$ model with aforesaid features has the following form—

$$\begin{bmatrix} A_{11} & A_{12} \\ A_{21} & a_{22} \\ v_1 v_2 \ldots v_m & v_{m+1} \ldots v_n \end{bmatrix} = \begin{bmatrix} a_{11}a_{12} & \ldots & a_{1m} & a_{1m+1} & \ldots & a_{1n} \\ a_{21}a_{22} & \ldots & a_{2m} & a_{2m+1} & \ldots & a_{2n} \\ \vdots & & \vdots & \vdots & & \vdots \\ a_{m1}a_{m2} & \ldots & a_{mm} & a_{mm+1} & \ldots & a_{mn} \\ a_{m+11}a_{m+12} & \ldots & a_{m+1m} & am+1m+1 & \ldots & a_{m+1n} \\ a_{m+21} & & \vdots & \vdots & & \vdots \\ \vdots & & \vdots & \vdots & & \vdots \\ a_{n1}a_{n2} & \ldots & a_{nm} & a_{nm+1} & \ldots & a_{nn} \\ v_1 v_2 & \ldots & v_m & v_{m+1} & \ldots & v_n \end{bmatrix}$$

The contents of the matrices A_{11}, A_{12}, A_{21}, and A_{22} are described on the right hand side of the above equation . Now, taking the $(I-A)^{-1}$ of the partitioned matrix we get—

$$\begin{pmatrix} I - A_{11} & -A_{12} \\ -A_{21} & I - A_{22} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} y_1 \\ -y_2 \end{pmatrix} \tag{2.13}$$

where x_1 is the n-dimensional vector of gross industrial outputs; x_2 is the k-dimensional vector of anti-pollution activity levels; A_{11} is the $(n \times n)$ usual matrix of inter-industry coefficient, a_{ij}, showing the input of good i per unit of the output of good j (produced by sector j); A_{12} is the $(n \times k)$ matrix of input structure coefficients of anti-pollution activities with a_{ig} representing the input of good i per unit of the eliminated pollutant g (eliminated by sector g); A_{21} is the $(k \times n)$ matrix of direct pollution output coefficient with a_{gj} showing the output of pollutant g per unit of output of good i (produced by sector i); A_{22} is the $(k \times k)$ matrix of pollution output coefficients for anti-pollution activities with a_{gk} showing the output of pollutant g per unit of eliminated pollutant k (eliminated by sector k); I is the identity matrix; y_1 is the n-dimensional vector of final consumption demands for economic commodities; and y_2 is the k-dimensional vector of the net generation of the pollutants which remain

untreated after abatement activity. Unlike the final demand of the conventional sectors, these untreated pollutants are not demanded rather tolerated. This tolerated level is fixed at standard level. It is therefore entered with negative sign. The g^{th} element of this vector represents the pollution standard of pollutant g as an indicator of its permitted level.

Equation (2.13) can be solved for the given levels of final demands of y_1 and y_2 (given pollution standards), through the inversion of coefficients, such that —

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} I - A_{11} & -A_{12} \\ -A_{21} & I - A_{22} \end{pmatrix}^{-1} \begin{pmatrix} y_1 \\ -y_2 \end{pmatrix} \tag{2.14}$$

The value of y_2 is entered with negative sign because the level of pollution is not demanded rather it is tolerated. We know the relevance of the $(I - A)^{-1}$ that it describes the total direct plus indirect effect of a rupee worth increase in the final demand on the total output of all the industries. Accordingly, generated pollutants in connection with the increase in level of all outputs contributing directly and indirectly to delivery to final users of a rupee worth increase is depicted by the matrix product,

$$A_{21}(I - A_{11})^{-1} \tag{2.15}$$

where A_{11} is the usual matrix of inter-industry coefficients and A_{21} is the matrix of direct pollution output coefficients. The result in equation (2.15) gives only the direct and indirect effect of the pollution generation contributed by a rupee worth increase in final demand of goods and services. While the total contribution of final demand in generation of pollutants output can be obtained by multiplying the direct-indirect coefficients with that of final demand. The following expression explains this relationship —

$$A_{21}(I - A_{11})^{-1}Y_k \tag{2.16}$$

where Y_k is the column vector of deliveries to final consumers of one particular kind.

2.2.1.1 Abatement Cost and Price Effect

The strategy of improving the environmental media through treatment of emissions has been examined by Leontief (1970, 1973). Leontief explicitly introduced columns to represent the pollution abatement process. The augmented model is then used for the generation and abatement of pollution. Miernyk and Sears (1974) also tried to calculate the effect of abatement cost but applied over all a different approach. Their study envisaged a dynamic regional $I-O$ model, and was focused to investigate the effects of compliance cost of 'US Clean Air Act, 1970'.

For the calculation of price effects Leontief used value-added price equations. Given the value added in each anti-pollution sector per unit of pollutant eliminated by it, the price effect of different pollution control strategy can be calculated. It is based on the following static value-added price equations—

$$P^k = V^k(I - A_{11})^{-1} \tag{2.17}$$

$$V^k = (v_1^k, v_2^k, v_3^k, \ldots, v_m^k)$$

where v_i^k represents the increment to value added coefficient to industry i resulting from the pollution control strategy k. With a given A_{11} matrix, the price of output of all producing sectors of the economy can be computed as a function of the value added (per unit of their respective output) for all the industries.

The system of price equations generated by Leontief can be used to explore the cost implications of pollution abatement. Thus, the impact of prices on all industrial sectors can be calculated when individual sectors pay fully or partially, the cost of reducing pollution.

Ketkar (1984) applied the adjusted $I-O$ coefficients approach for abatement cost. The study was based on the observation in U.S. that the effect of meeting US controls on pollution in the early 1970s was to raise the prices on average by 1.4%. In the major polluting industries, 3%-12% price increase has occurred. Leontief's basic

input-output model of environmental repercussions was applied by using the $I - O$ table of the US economy. The analysis was performed for the past observations and expected future changes for the years 1958, 1963, 1967, and 1980. It was tested on five air pollutants – particulate, sulfur oxides, hydrocarbons, carbon monoxide and nitrogen oxide. The matrix comprising these pollutants was derived from the sampling estimates of primary information collected for the industries. Leontief himself admitted that within the same theoretical framework the model could be successfully applied on water pollution.

2.2.2 Extensions to the Leontief Model

The augmented model of environmental repercussions received widespread attention worldwide as a tool of studying environmental modeling. Mainly two formulations of the model are presented in the literature (Leontief, 1970). According to first version of the model tolerated level of pollutants or environmental standards are taken as exogenously given on the right hand side of the model with negative entries (Leontief, 1970, Lowe 1979, Miller and Blair, 1985). The other version considers the standards in such a way that the economy eliminates a given proportion of the total pollutants. The proportion of gross pollutants which is subject to treatment, enter the model as explicitly given variables, instead of as, absolute levels of untreated net pollution [Leontief, 1970; also Steenge, 1978; Lowe, 1979; Arrous, 1994].

Under this framework several attempts have been made to reformulate the model, by including the pollutants explicitly as sectors, in various ways. Flick (1974), Steenge (1978), Rhee and Miranowski (1984), Qayum (1991), Arrous (1994), Luptacik and Bohm (1994, 1999), Lager (1998) and many others worked on Leontief model and tried to extend it differently.

Leontief model was based on the non-negative solution of the vector of gross output for a given level of final demand. A counter example given by the Flick (1974) showed a negative level of activity of anti-pollution sector. Flick pointed out certain

inconsistencies and found that Leontief's model gives correct predictions only when the economy produces more pollution than the tolerable limit. In a situation when the tolerable limit is high enough to leave the anti-pollution industry idle, the model computes erroneous level of output. The model fails to account for certain dependencies in two different situations. The interdependence is found in the quantity equations, but the same has not been observed in price equations. Any increase in the final demand requires more output, thereby it causes more pollution. Since the tolerated amount of pollution is fixed, it can not be altered with the increase in the level of economic activity; the anti-pollution industry must increase its operation to offset the additional pollution generated by the final demand of a product. The price equations are unable to justify this interdependence between the producing sectors and the anti-pollution sectors of the economy.

In order to eliminate the inconsistencies Flick suggested an alternative formulation with an additional pollution service sector. This sector was meant to provide a service of discharging pollutants into the environment, through various environmental media, such as, air. The other anti-pollution sector remains identical with that of Leontief. By introducing separate rows and columns for pollution service and anti-pollution sectors, Flick managed to remove the interdependencies mentioned just above, under this alternative setting.

In a rejoinder to these simple modifications Leontief (1974) negated the relevance of another 'environment service' or 'pollution service' sector. According to Leontief, the model was not successful in formalizing a new conceptual argument or factual conclusion and thus, can not be considered a meaningful contribution. The model also lacks concise mathematical reformulation. In that sense Flick's alternative formulation proved to be a different terminology rather than a different conceptual argument.

Steenge (1978) also tried to reformulate the model; he showed that the counter example given by the Flick was not appropriate. The Flick's example was unable to observe certain dependencies between the model's equations. The level of tolerated and

eliminated pollution are not independent in the model because the tolerated pollution can not exceed the total pollution in an economy. It is shown in the analysis that the substitution is possible in Leontief's model. This substitution gives an adjusted technical coefficient and adjusted value added coefficients. This adjustment is in terms of industry participation in anti-pollution measures. Then the prices are derived as a function of adjusted value added system and 'polluter pays principle'.

If the coefficients of the matrices A_{21} and A_{22} are entered with a negative sign, then the physical input-output relation becomes—

$$\begin{pmatrix} I - A_{11} & -A_{12} \\ A_{21} & -I + A_{22} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix}$$

Now identities of the system are—

$$(I - A_{11})x_1 - A_{12}x_2 = c_1 \tag{2.18}$$

or

$$(I - A_{11})x_1 = c_1 + A_{12}x_2 \tag{2.19}$$

The value of x_2 can also be derived–

$$A_{21}x_1 + A_{22}x_2 - Ix_2 = c_2$$

or

$$(I - A_{22})x_2 = A_{21}x_1 - c_2 \tag{2.20}$$

which gives,

$$x_2 = (I - A_{22})^{-1}(A_{21}x_1 - c_2) \tag{2.21}$$

$(I - A_{22})$ satisfies the Hawkins-Simon condition. This implies that the anti-pollution industries should not generate more pollution than they eliminate. In this case $(I - A_{22})$ will be non-singular and $(I - A_{22})^{-1}$ will be positive. Thus, a non-negative solution x_2 would depend upon the relation between x_1 and c_2. If $(A_{21}x_1 - c_2)$ is negative,

the corresponding element of x_2 can be negative, depending upon the elements of A_{22}. If produced pollution $A_{21}x_1$ exceeds tolerated pollution levels c_2, a non-negative x_2 is guaranteed. The relationship between tolerated emissions c_2 and eliminated pollution x_2 can be explained by the parameter α,

$$c_2 = \alpha x_2 (\alpha \geq 0) \tag{2.22}$$

when $\alpha = 0$, no pollution is allowed. And when $\alpha = 1$, the amount of eliminated pollution x_2 equals the delivery to the environment. It has been shown that in this case abatement would be 50%. Now, the question remains with the choice of abatement policy. Given the equation (2.18-2.22), we may write—

$$A_{21}x_1 - (I - A_{22})x_2 = \alpha x_2 \tag{2.23}$$

or

$$-(I - A_{22})x_2 = \alpha x_2 - A_{21}x_1$$

or

$$\{(1+\alpha)I - A_{22}\}x_2 = A_{21}x_1$$

$$x_2 = \{(1+\alpha)I - A_{22}\}^{-1}A_{21}x_1 \tag{2.24}$$

which gives,

$$(I - A_{11})x_1 - A_{12}\{(1+\alpha)I - A_{22}\}^{-1}A_{21}x_1 = c_1$$

or,

$$x_1 = (I - A^*)^{-1}c_1 \tag{2.25}$$

with,

$$A^* = A_{11} + A_{12}\{(1+\alpha)I - A_{22}\}^{-1}A_{21}$$

The value of x_2 can be derived from equation (2.24 and 2.22) which gives the value of c_2. Likewise, the adjusted value added coefficients and total labor demand L can also be derived.

$$L = v_1x_1 + v_2x_2$$

From equation (2.24) we know the value of x_2. Now,

$$L = [v_1 + v_2\{(1+\alpha)I - A_{22}\}^{-1}A_{21}]x_1 = v_1^* x_1$$

Here, v_1^* is the adjusted value added coefficients and L total labor demand. Now, the cost consequences of the polluting activities can be easily known by rewriting the equations in a case when polluter pays fully for the damages caused by the polluting activities. By rewriting equations (2.19-2.22) we get,

$$P_1(I - A) + P_2(-1+\alpha)^{-1}A_{21} = v_1$$

$$P_1(-A_{12}) + P_2[I - (1+\alpha)^{-1}A_{22}] = v_2$$

All abatement cost is borne by the polluter and $100^*(1+\alpha)^{-1}$ is charged to business. In another case when polluter pays for its damages partially, the prices are different. In this case $100^*\beta\%$ $(0 < \beta < 1)$ is charged with the business.

Lowe (1979) extended Leontief's example in a broader context by allowing a linear programming technique to choose among production techniques and abatement activities when pollution standards are imposed.

Luptacik and Bohm (1994) investigated the conditions for the existence of non-negative vectors of gross output and abatement level for any level of final demand and tolerated level of pollution. The emphasis was put on the conditions for the existence of non-negative solution defined by exogenous parameters of model. Flick, Steenge, Miller and Blair also tried for the same. Luptacik and Bohm proved that under the Leontief system if,

$$A_{21}(I - A_{11})^{-1}y_1 \;\geq\; y_2 \tag{2.26}$$

condition fulfills, then, the vector of gross industrial output is non- negative. The non-negative vector of abatement activities can be guaranteed if—

$$C^{-1}[A_{21}(I - A_{11})^{-1}y_1 - y_2] \;\geq\; 0 \tag{2.27}$$

also,

$$C^{-1} \geq 0$$

Under the fulfillment of Hawkins-Simon condition all exogenously given final demands y_1 and tolerated pollution levels y_2 in equation (2.26) will ensure the non-negative values for the vectors of gross industrial outputs x_1 and for the vector of the abatement activities x_2.

Equation (2.26) implies that if the level of pollution generated by the producing sectors, for a given level of final demand, is higher than the accepted tolerance limit, then the difference must be abated. However $x \geq 0$ implies that $x_1 \geq 0$. Any abatement requires inputs from the economic sectors. Thus, a non-negative production is guaranteed. The same results were drawn by Steenge (1978), and Miller and Blaire (1985). But in this formulation a non-negative solution x_2 depends on the relationship between endogenous vector x_1 and exogeneously given vector y_2.

Lager (1998) has utilized the Ricardo's theory of differential rent, which is based on the possibility of coexisting technical alternatives for the analysis of environmental policies. According to him if the cost of pollution is taken into account, then the 'choice of technique' problem can not be circumnavigated and therefore Leontief fixed coefficient approach becomes redundant. Environmental policy instruments lead to a change in system of prices. This in turn induces substitution in production as well as in consumption. Therefore, substitution becomes central issue.

The assumption of lack of substitution and the given 'value-added' in Leontief's model lead to serious problems. A change in the structure or in the level of final demand for products, in general, change the total amount of pollution generated. Keeping the amount of tolerated emission constant, the percentage rate of tolerated emission must change. Thus, price will vary with quantities. It is demonstrated that the Leontief model is either inconsistent or based on implicit assumption that rate of profit is zero. In some cases pollutants once released into the environment can no longer be treated. Lager presented a model which can be applied even in those cases where abatement technologies are not feasible. The underlying assumption to apply Ricardian differential rent is that environment can be appropriated and permits to pollute are

sold to the polluting agents and they will have the choice of using more-or-less polluting technologies.

Rhee & Miranowski (1984) incorporated income as an endogenous variable and used a variation of the multiplier approach to solve the Leontief's extended model.

Qayum (1991) presented a reformulated model. In this model instead of pollution sector, 'clean air' sector is introduced. These two sectors are similar in a sense that a gram of pollution eliminated is equivalent to a gram of clean air produced. The final delivery of clean air denoted by Y^* is equivalent to the tolerated amount of pollution $-Y$ in Leontief's formulation. If the amount of air pollution tolerated, Y is negative then Y^* is positive. However, if Y is positive, then Y^*, the final delivery of clean air is negative. On the basis of polluter pays principle,therefore, higher prices are obtained. The physical flows of the system bring more output under the assumption that air quality in the economy remains unchanged ($Y^* = 0$). This reformulation also keeps Leontief system intact.

Arrous (1994) presented a systematic formulation of the Leontief model and tried to integrate the numerical example given by both Leontief and Qayum. The analysis is done in terms of the anti-pollution norms. The fulfillment of these norms leaves an effect on economic activity and employment. Secondly, anti-pollution efforts must be financed and this leaves effect on relative prices and cost bearing on economic agents. Arrous deals with these two questions under the $I - O$ framework. A system of price determination and physical quantities is obtained at the end.

2.2.3 Empirical Studies under the Input-Output Framework

Input-Output models have widely been used for the enviornmental analysis. In most of the empirical literature, covering environmental pollution, energy based emissions have been studied [Reardon (1973), Herendeen (1978), Harris, McConnell and Cumberland (1984), Bergman (1988), Gay and Proops (1993), Prrops et.al (1996), Ostblom (1998),

Wier (1998)]. However, in limited instances cumulative pollution intensity generated out of inter-relationship effects among the sectors of the input-output table, has also been analysed [Leontief and Ford (1972), Miernyk and Sears (1974), Forsund and Strom (1975), James et al. (1978)]. In the past few decades, considerable number of macro-economic studies have been done to cover the carbon-dioxide and other emissions, [Glomsrod, Vennemo and Johnsen, (1994), Common and Salma (1992), Larsen (1997), Symons, Proops and Gay (1994), Zhang (1998), Conrad and Schmidt (1998), Kratena and Schleicher (1999), Barker (1999)].

Forsund and Storm (1975) examined the cumulative effects of residual flows for Norwegian economy. The interdependence among production sectors is traced through the 26 sectors $I - O$ model. In their analysis, some parts of the demand for sectoral products, have been made endogenous. In that sense their model is dynamic. The generation of residuals is treated as joint production of the regular producing units. The joint production concept is represented by the discharge coefficients, which gives a ratio of residuals and the gross production from a particular sector. It is represented by the following relationship—

$$d_{ij}^{\alpha} = \frac{W_{ij}^{\alpha}}{X_j} \tag{2.28}$$

where, d_{ij}^{α} is the discharge coefficient, W_{ij}^{α} is the volume of residual discharged by sector j to the recipient α(air, land and water), and X_j is the volume of gross production in sector j measured in monetary terms. The total amount of residuals discharged in the economy, is represented by the following equation—

$$R_i^{\alpha} = \sum_{j=1}^{26} d_{ij}^{\alpha} X_j + R_i^{c\alpha} + R_i^{G\alpha} + R_i^{f\alpha} \tag{2.29}$$

where, R_i^{α} is the total amount of residual discharged into the recipient α, $R_i^{c\alpha}$ is the amount of residual i generated through consumption and $R_i^{G\alpha}$ indicates residuals from the military defence and the use of the roads. $R_i^{f\alpha}$ is the difference of the residual i to the national recipient minus, the amount of residuals generated by Norwegian activities abroad, mostly by ocean water transport. $R_i^{c\alpha}$and $R_i^{G\alpha}$ in equation (2.29) are estimated

outside the model. The $X_j's$ are determined within the model and d_{ij}^{a} is calculated from equation (2.28).

The data was collected through questionnaires which provided cross-section data for 1970, covering about 70% of total production. Multi-Sectoral growth (M-S-G) model is applied for the analysis.

Hawdon (1995) examined the energy-environment and economy interactions in U.K. A 10 sector I-O model has been followed at a high level of aggregation. The implications of the relationship between the income, expenditure, output and environment have been investigated. Under this framework changes in one set of variable generate a series of repercussions in the economy. The model is designed on the four main structural features. The interaction between these features determine the nature of the response to any exogenous variable or parameter. These features include—

1. The pattern of consumer spending by income groups (via expenditure coefficients).

2. The inter-industry production structure which also includes appropriately disaggregated energy sectors (via I-O coefficients)– there are five energy sectors- coal, oil extraction, oil processing, electricity and gas-plus agriculture and forestry, construction, manufacturing, transport and services.

3. The distribution of personal disposable income groups generated in each production sector (via value added distribution coefficients)

4. The structure of environmental effects from production, consumption and use of energy (via coefficients for sulfur, NO_x, and CO_2, for European deposition).

All these features were studied by a model called ENDAM (Energy Economy Environmental Damage Model) model and it was used for computer implementation of 10 sector I-O model. ENDAM is used to explore the complexities of interrelationship between energy and environmental issues. The efforts have been made to investigate

the impacts of changes in final expenditure taxation and energy intensities on economic activities, energy demand and air polluting emissions.

Gay and Proops (1993) applied the Leontief approach to examine the CO_2 emissions in the UK for producing as well as consuming units. The analysis is done in terms of use of fossil fuels for direct consumption demand, direct production demand and the indirect production demand. The carbon requirement per unit output of each sector is calculated for the estimation of CO_2 production. The relationship between the environment and economic activity is established under the Leontief framework. The model is constructed in the following way—

The use of total industrial fuel is depicted by the $3-vector$ matrix f.

$$f = C'X \tag{2.30}$$

where C is a $(3 \times n)$ matrix of coefficients of fuel use per unit of total output. C' is the transpose of C. Total fuel consumption by final demand category is given by $3-vector$ d matrix.

$$d = P'y \tag{2.31}$$

From equation (2.30) and (2.31), total fuel use for each fuel becomes–

$$f + d = C'X + P'y \tag{2.32}$$

where P is a $(3 \times n)$matrix of the coefficients of fuels used by consumers. We know that $X = (I - A)^{-1}y$. Now,

$$\begin{aligned} f + d &= C'(I-A)^{-1}y + P'y \\ &= [C'(I-A)^{-1} + P']y \end{aligned}$$

Now, the total CO_2 emissions from fuel use (E) can be written as—

$$\begin{aligned} E &= e'[f+d] \\ &= e'[C'(I-A)^{-1} + P']y \end{aligned}$$

Then, CO_2 emission from non-fuel sources (N) can be written as—

$$\begin{aligned} N &= m'X \\ &= M'(I-A)^{-1}y \end{aligned}$$

Now, the CO_2 emission from all sources (T) can be written as—

$$\begin{aligned} T &= E+N \\ &= e'[C'(I-A)^{-1}+P']y+m'(I-A)^{-1}y \end{aligned}$$

$$T = [e'C'(I-A)^{-1}+e'P'+m'(I-A)^{-1}]y \qquad (2.33)$$

No estimates have been made for M. Gay and Proops only attempted to calculate the first part of the equation (2.33).

$$T^{\star} = [e'C'(I-A)^{-1}+e'P']y \qquad (2.34)$$

$$T^{\star} = e'P'y+e'C'y+e'C'(A=A^2+A^3\ldots)y \qquad (2.35)$$

Here, $e'P'y$ in equation (2.35) calculates the emissions because of 'direct consumption' demand for fossil fuels, while $e'C'y$ represents CO_2 emission because of direct production demand for fossil fuels. $e'C'(A+A^2+A^3+\ldots)y$ is the CO_2 emission attributed to 'indirect production demand' which arises from the intermediate sources of fossil fuels.

The model was applied for the $I-O$ tables of 1984. The (102×102) $'A'$ matrix was aggregated into 38 sectors $'A'$ matrix. The analysis is performed on the basis of certain assumptions regarding the generation of fixed CO_2 per ton of fossil fuel used for all solid, liquid and gaseous fuels.

2.3 Indian Studies

Environmental revolution in India arrived lately. Only in the last two decades government has taken some active steps to curb the adverse environmental impacts of the

developmental process. Economic profession has also realized that the environmental problems can not be left only on the technological characteristics of the economy. These problems also need economists' attention through a straight forward set of policy implications. As a result the emphasis on 'command and control', driven by the technological factors, is now shifted to the economic instruments.

The empirical literature on industrial pollution is scant, not because of the lack of realization of facts on policy front but also because of the ignorant behavior of the environmental authorities regarding the development of systematic environmental database and other resources, needed for policy research. In view of these factors it is difficult to extract a single tool to study the impacts of industrial pollution. Das Gupta and Murty (1983), Tiwari and Parikh (1995), James and Murty (1996), Agarwal et al. (1996), Reddy and Parikh (1997), Misra (1998), Goldar and Mukherjee (1998). Murty, James and Misra (1999), Murty et al. (1999), Nag and Parikh (2000), applied different tools and discussed the environmental problems related to the external damages inflicted on environmental resources by various developmental activities.

Das Gupta and Murty (1983) studied the case of the paper and pulp industries. It was found in their study that the small and large paper mills have different environmental implications. The production cost estimates of small and large industry however, shows that production cost in small industries is considerably less, as they use non-conventional inputs such as agricultural residues. But the environmental problems associated with the small industries are immense. Also, there are substantial differences in the characteristics of the wastewater. For them it is not economically viable to have pollution abatement plant. The abatement cost estimates of small and large units show that comparative capital and operating cost, per ton per year, of abatement is more than double in smaller units. It is also found that as the industry size increases the abatement cost per ton per year falls. Misra (1998) also confirms the same result as the volume of wastewater treated increases the abatement cost falls sharply. Misra talks about the economies of scale in water pollution abatement activity and takes the case of a cluster of 250 small-scale industries. It is shown in the study that since cost

burden on small industries is substantially high, the cost advantages can be achieved only by way of common effluent treatment plant.

Tiwari and Parikh (1995) analysed the case of construction industry and found that because of the use of high energy-intensive materials, construction sector contribute for maximum carbondioxide emissions in the economy. Nag and Parikh (2000) discussed the comercial energy consumption patterns in India in terms of primary energy requirements. In their study, the implications are drwan for canbon dioxide intensity. Other studies include Agarwal et al. (1996); James and Murty (1996). Agarwal et al. studied the wastewater characteristics of distilleries and found that the concentration of pollutants in this industry is much higher than the prescribed norms of the MINAS. In most of the cases it is not possible to bring the pollutants to the prescribed level because of the substantial capital and operating cost. James and Murty (1996) discussed about the economic instruments for environmental protection. Murty, James and Misra (1999) studied the case of water pollution in terms of benefit-cost analysis.

There have been very few studies done in India with input-output (I-O) technique to study the enviornmental impacts. Murthy, Panda and Parikh (1997a, 1997b) applied I-O technique for the analysis of the economic development and carbon emissions in India. No such attempts have been made to study the industrial pollution explicitly under the input-output framework. Murthy et al. (1997a) studied the linkages between emission, energy and economy by examining the consumption and production pattern in India. They attempted to analyze the level of carbon emission on the basis of energy consumption in different producing and consuming units. The direct energy consumption in different producing sectors of the I-O table is obtained by the sum of energy utilization in different forms, in each sector, measured in common unit 'joule'. On the basis of direct energy intensity of various sectors, the direct and indirect energy requirement to meet a unit level of final demand in different sectors, is calculated.

A similar kind of analysis is done by Murthy et al. (1997b). They attempt to analyze the carbon-dioxide implications of economic growth and associated structural

changes in India over a period of 1990-2005. The implications of poverty reduction, energy conservation programs, on CO_2 emissions are also considered.

The above literature review shows that different problems have been studied from different perspectives. The choice of a particular model or technique in all the studies has been influenced by the nature of the problem, data availability etc. Even in the present study the choice of technique is constrained by several factors. The following section discusses about the methodology and the choice of model.

2.4 Choice of Technique

To study the trade-off between the environment and the economy, an effective modelling tool is warranted so that the complex economic and physical inter-relations can be studied simultaneously at macro as well as at disaggregated micro levels. Input-output (I-O) modeling is one of the standard techniques for the analysis of the structural inter-relatedness among the large number of variables. Certain classes of environmental problems can very well be studied under this system modeling. Its modeling capabilities and results offer a wide range of opportunities for policy options including impacts on quantities, prices and costs of industrial activities. It provides a conceptual theoretical frame to study the environment and economy interactions. The integration of environment and economy, facilitate its use in empirical analysis, [see Zucchetto (1984), Forssell, 1998]. The integration of environment and economyThe technique is highly appropriate for the study of trade-off between the environment and economy in general equilibrium frame work.

Although I-O technique is not a unique technique for the analysis of environment-economy modeling. Numerous other models including growth models and econometric models have been applied on the environmental problems. Each of these models are constructed on different types of theories and raised issues of different natures. Therefore, choice of model has varied with different tools and objectives. Here aim is not to

discuss the alternative techniques to handle the environmental problem but the role of input-output model has been stressed for the analysis of industrial pollution. For the purpose of present study, input-output models are well suited to handle the problem at a fairly dis-aggregated level. The level of pollution generated in the past and predictions in the level of pollution for the future changes can be well studied under this framework. Input-output technique has several advantages over the other techniques. Firstly, the problem can be handled at a detailed sectorisation level in comparison to other modeling techniques. Secondly, all sectors of production and units of consumption are included in the model, in that sense the model become a complete illustration of the economy, hence interaction effect among the producing and consuming units can well be captured. Thus, owing to the nature of the problem of the present study and the availability of data, input-output approach is the best suited approach and hence has been adopted as a methodological choice for analyzing the problem of industrial water pollution in India over the period 1983-84 to 1993-94.

2.5 Choice of the Model

As we have seen in the literature review that the interaction between the economy and the environment has been studied from several perspectives. In many of the studies Leontief's model has been applied to study the industrial pollution. As mentioned in the literature review that many extensions and modifications have been suggested from time to time. But in all those cases fundamental relationship of the Leontief's enviornmental model has remained same. In some of the cases only different terminology has been used. Thus, Leontief model is still found relevant to study the cumulative effects of the industrial pollution. The possiblities offered by the model are enormous and can easily be applied in the Indian context. Moreover, the availability of the data regarding industrial water pollution also make it convenient to use the Leontief's model. Because availability of data limits the application of any complex model in Indian situation. Secondly, the possibilities offered by the extended or modified models in some or the

other way remains same as of the original Leontief model. Thus, the model still throws up challenging domains and enormous scope for the study of environmental effects. Because of these reasons Leontief model is most suitable in the present context.

Empirically, very little use has been made of I-O technique to study the industrial pollution. In most of the empirical literature emissions associated with the use of energy have been studied. Gay and Proops (1993), Hawdon (1995), Proops (1996), Wier (1998), Ostblom (1998), have concentrated their work on the factors associated with energy based emissions. There have been very few attempts to study the cumulative pollution intensities. Though the studies of Leontief and Ford (1972) for the USA, Miernyk and Sears (1974) for West Virginia USA; James et al. (1978) for the Netherlands; Forsund (1975) for Norway, have made such attempts, but most of these studies have been conducted for the air pollutants. No such attempts have been made on water pollutants. In India too there are very few descriptions and studies available for industrial water pollutants. Murthy, Panda, Parikh (1997a, 1997b) applied I-O technique for the analysis of the consequences of economic development on carbon-dioxide emissions.

The understanding of environmental issues related to industrial water pollutants is very much essential for the resource utilization and planning. The growing pollution in our watercourses and the complexity of this problem has already increased the risk of more destruction in future [see Gajjar (2000), Nighojkar (2000)]. Now, it is very much essential to consider the environmental factors, associated with water pollution, at par with production. It not only minimizes material losses but also makes production more viable. So there is a need to evaluate the production process in the limelight of the increasing pollution. The objective of the present study is to derive the cumulative water pollution effects those are generated during the process of production. The generation of pollution due to inter-dependence of the sectors has dominant role in the total pollution generation. The Leontief model proves to be the most appropriate and therefore has been choosen among the others for the present study.

The present study distinguishes itself in four ways. First, it is the first attempt of its kind to deal with the industrial water pollutants explicitly, although at a high aggregated level for 56 sectors. Secondly, the study involves 36 different types of organic, inorganic and radioactive water pollutants. Thirdly, the study covers a considerable long period of 10 years. Finally, technological factors have also been analyzed explicitly.

2.6 Methodology

Input-output technique proved to be the promising approach for the present study. The analysis of environmental repercussions generated by the inter-relationships of the production process are better understood by this model than any other analytical tool or model. The Leontief's augmented model of environmental repercussions is applied here for the present purpose. Under this model, the regular $I-O$ table is extended to cover the environmental effects. The simplest way of extending the $I-O$ table is to introduce additional rows for each pollutants, where element j in a row represents the physical quantity of that pollutant emitted by sector j (Leontief, 1970, Miller and Blaire ,1984). These rows are extended on the basis of linearity assumption that the relationship between each sector's output and the quantity generated of a particular pollutant remains constant. In this way coefficients of pollutants per unit of sectoral output can be derived. Now the question remains that whether these coefficients should be associated with the industry output or commodity output level. Analytically, commodity by commodity model should be adopted if pollutants are a function of commodity output and an industry-by-industry model is suitable when pollutants are a function of industry output level. Victor (1972) considered commodity-by-industry table (a make matrix) in which residuals are added as joint products. Leontief and Ford (1972) and Forsund and Storm(1975) adopted commodity-by-commodity table for the analysis and the rows were extended on the basis of the industry survey data.

Now, the physical quantity of residuals can be estimated as a function of the

industry outputs. These can be used for the estimation of direct residuals-output or pollution-output coefficients. In equation form we have,

$$R = E\hat{X} \tag{2.36}$$

where R in equation (2.36) is a matrix of residuals generated by industry outputs, each element r_{kj} is the amount of residual K generated by industry j; E is a direct pollution coefficient matrix and each element e_{kj} is the quantity of residual k generated by industry j and $\hat{X}$ is the diagonal matrix of industry outputs measured in monetary units.

Equation (2.36) determines the direct pollution effect generated by each industry in its operation. However, any change in final demand will have relevant feedback effect on the output of other sectors and ultimately on residual flows. The residual flows generated in different stages of interaction process can be shown as a function of final demand. From the basic $I - O$ model, we have—

$$X = (I - A)^{-1}F \tag{2.37}$$

where F is a vector of final demands, X the vector of equilibrium outputs and $(I-A)^{-1}$, the Leontief inverse matrix, all expressed in monetary units. From equation (2.36) the total quantity of each residual generated by all industries can be found by summing the rows of R. we have—

$$Z = Ri' \tag{2.38}$$

$$= EX \tag{2.39}$$

where Z is a vector of total residuals by type, and i is a sum vector. Now, equation (2.37) can be substituted in equation (2.39) to obtain the relationship between the final demand and residual flow. Now,

$$Z = E(I - A)^{-1}F \tag{2.40}$$

if

$$C = E(I - A)^{-1} \tag{2.41}$$

then,

$$Z = CF \tag{2.42}$$

Equation (2.41) not only captures the direct but also indirect environmental repercussions of different patterns of final demand. In this way the total water pollution intensity (direct plus indirect effect) for each pollutant is derived by pre multiplying its vector of direct pollution output coefficients by the inverse inter-industry matrix from the I-O model. In equation (2.39) the elements of C explores the direct and indirect (cumulated) pollution output coefficient into account. Each C_{kj} represents the total amount of residual K generated directly and indirectly per unit of final demand of industry j.

2.6.1 Technological Effect

The technology in $I-O$ table is depicted by the structural coefficients. These coefficients are expected to remain stable over time, at least for the period in which $I-O$ table has been constructed. This stability of technical coefficients implies the fact that technology is embodied in factors of production. The other issues of social and cultural change related with technology are not considered in this approach. Thus, technology is the central factor in the production process and for each sector specified production function is given which is relatively fixed for the year for which the $I-O$ table has been constructed. Change in technology reflect only the change in relationships among different sectors and requirements of primary inputs over time.

Carter (1970) uses an $I-O$ framework to analyze the impact of structural change on the US economy. He explained the methodology of technological comparability from the $I-O$ table. Simple methodology of the representation of technology can be taken by the comparison of two tables. Let the old technology matrix be A_0 and the new A_1. Assume a given final demand vector x. The essence of the approach is to compare the total requirements of primary and intermediate inputs for the generation of X, using

technology A_0 and technology A_1, (see Stoneman, 1983).

Carter used this approach for the US economy and compared the 1947 and 1958 input requirements to supply the same final demand vector. The 1962 bill of goods of final demand was taken for the analysis. Then, the output level required to produce the same 1962 final demand from both the technologies was estimated by multiplying the Leontief inverse matrices $(I - A)^{-1}$, by an estimated final demand vector. Forssell (1988) also applied this model with slight modifications on Finnish economy in the 1960s and 1970s.

For the present purpose of the analysis this approach has been adopted. The details of the methodological model will be considered in the relevant chapters wherever the need arises. The next chapter present the details about the data and various adjustments made for the empirical research.

Chapter 3

The Data

This chapter aims to describe in detail, the various sources of data, their characteristics and limitations. The sole data utilized for the present study is provided by the Central Statistical Organization (CSO) in the form of Input-Output Transaction Table (IOTT) for the years 1983-84, 1989-90 and 1993-94. Other set of data required for the environment pollution matrix is collected from different secondary sources. Hence, first section of this chapter explains the principal characteristics of the Indian Input-Output tables. In the second section of the chapter, inter-temporal comparability of the Indian Input-Output tables are discussed so that these tables become consistent with each other, when any conclusion is drawn from the comparison. Finally, the third section describes the other data sources such as, pollution, price indices etc of different sectors.

3.1 Principal Features of the Indian Input-Output Tables

The Input-Output Tables of the Indian economy used in this study for the year 1983-84, 1989-90 and 1993-94, can be described as 'open, static Leontief' type tables. The first

Input-Output Transaction Table (IOTT) consistent with the national accounts statistics (NAS) for the year 1968-69 was prepared with the joint efforts of the Planning Commission and Central Statistical Organization (CSO). Subsequently, from the year 1973-74 and onwards CSO undertook the responsibility of preparing and publishing the I-O tables on a regular interval of five years. Since then, the CSO has brought out the detailed report on IOTT for the years 1978-79, 1983-84, 1989-90 and 1993-94. After 1978-79, according to the five yearly program, the next IOTT was to be published for the year 1988-89. But from this year all companies/establishments were to uniformly adopt financial year accounting system. Consequently, 1988-89 Annual Survey of Industries (ASI) had problems regarding this and the data of different units varied from few months to more than a year, distorting the structure of major manufacturing sectors. Hence, 1989-90 was selected for the IOTT reference year. After 1989-90 the next IOTT has been constructed for the year 1993-94.

For the present purpose of the study 1983-84 (CSO, 1990), 1989-90 (CSO, 1997) and 1993-94 (CSO, 2000) I-O tables have been selected. Obviously, selection of these years is subject to the availability of IOTT with the CSO.

The 1983-84 year has been selected as a starting point of reference because most of the environmental legislation came into force only after 1980. Thus, for the present purpose of the study, analysis has not been performed prior to the year 1983-84, irrespective of the availability of I-O tables. Another year 1993-94 has been selected as terminal year because it is the most recent period for which I-O table is available. The effect of technology and final demand intensity on the pollution generation is more accurately being undertaken for the period 1983-84 to 1993-94.

The basic Input-Output Transaction Table (IOTT) for all the reference years are prepared in the form of absorption (*commodity* $\times$ *industry*) matrices at the current factor prices, that records the commodity inputs to an industrial production process. The column represents the industries or more precisely group of industries and the row indicates group of commodities. Reading down each of its column shows the amount

of different commodities absorbed as intermediate inputs by a particular industry for the purpose of current production. Each of its row shows the amounts of a particular commodity absorbed as intermediate inputs by the various industries. The bottom entries of the column contains the value of primary inputs in terms of income from use of labor and capital, that is, gross value added (GVA) and net indirect taxes (NIT).

The purpose of the $(Commodity \times Industry)$ accounts is to deal with the problem of secondary production. Since IOTT is in the form of commodity-by-industry matrix, the column sums i.e. the total commodity output does not tally with the row sums or industry output in the case of manufacturing sectors. This is so because by-products are also manufactured by the industries along with their main product. The columns of the absorption matrix show the main products as well as the by-products while the rows of the absorption matrix show only main products. While determining the entries in the rows, a by-product of an industry is transferred to the sector (commodity row) whose principal product is the same as by-product under reference, which is the cause of difference between the row sums and the column sums.

All the input-output tables under the reference years are prepared for the common 60-sector classification. However, detailed classification of 1968-69 I-O table is prepared for 230 sectors, while other input-output tables i.e. 1973-74, 1978-79, 1983-84, 1989-90 and 1993-94 have been prepared for 115 sectors. Scheme of sector classification for the years 1968-69 and 1973-74 is exactly same but differs with the I-O tables of the subsequent years. In the sector classification scheme of 1978-79, the communication and electronic equipment emerge as separate sector and that manufacture of aircraft had been merged with the miscellaneous manufacturing activity. This change was essential because electronic good industry gained substantial importance and required separate treatment in economic analysis. Similarly, no commercial aircraft have been manufactured in the economy. Only repair service has been provided. Therefore, this activity was merged with the miscellaneous manufacturing and in this way the number of sectors were intact to 115.

The first 32 sectors in the classification of IOTT represent primary production, the next 66 sectors relate to manufacturing industries and the remaining 17 sectors deal with the tertiary activities. The final demand category in all the reference years has been distinguished under six components,

1. private final consumption expenditure (PFCE);
2. government final consumption expenditure(GFCE);
3. Gross fixed capital formation (GFCF);
4. Change in stocks (CIS);
5. Exports of goods and services (EXP) and
6. Imports of goods and services (IMP).

The PFCE includes expenditure of residents and non-resident households in the domestic market and non-profit institutions. GFCE is taken as current consumption expenditure of the government, which comprises compensation of employees, depreciation and intermediate consumption. CIS includes semi-finished goods, the part of the output being held by sectors producing these outputs and hence these are free of trade, transport margins and net indirect taxes. Export has been considered as demand of domestic output by foreign countries, which comprises merchandise f.o.b. and other items like transport and communication in respect of exports other than merchandise, insurance etc. Imports are taken c.i.f. values and included in final demand as negative entries. All the entries in the IOTT are at factor cost, i.e. excluding trade and transport charges and net indirect taxes (indirect taxes less subsidies).

IOTT in all the reference years are at factor cost, i.e. excluding trade and transport charges and net indirect taxes. The IOTT, to begin with, is prepared at original purchasers price, i.e. at the price in which the actual transaction takes place. The entries at factor cost are arrived thereafter by removing the components of trade and

transport margins and net indirect taxes. These have been shown in separate rows in the table. The row of net indirect taxes thus depicts the taxes paid by the industries on intermediate inputs used in the process of production of industry's output. The matrix of net indirect taxes is obtained by adding the individual matrices of import duty, excise duty, export duty, sales tax and other taxes and subtracting the matrix of subsidies. Up to this point analysis is done in terms of absorption ($commodity \times industry$) matrix, recording the input of commodities into industries for all reference years. Other matrices which provide basic information to the input-output system of the economy are the make ($industry \times commodity$) matrix. The rows of this matrix describe the commodities produced by industries in the economy and the columns describe the industry sources of commodity production. The elements of the leading diagonal are the primary (characteristic) product of an industry while off-diagonal elements are the secondary products. No final demand entries are made in this matrix. The coefficient matrix of this table is prepared with the help of proportion of an industry into commodities produced as the main product of various industries. From these two basic I-O tables, CSO has derived other matrices viz. $commodity \times commodity$ and $industry \times industry$ matrix under different technology assumptions.

Preparation of $commodity \times commodity$ and $industry \times industry$ tables require transfer of inputs and outputs between sectors and this is done under certain assumptions. For the construction of these tables secondary products are transferred to the industries where they are principally produced. The two alternative assumptions for transferring of outputs of secondary products are (1) assumption of an industry technology where every industry has its own technology determined by its principal product. In other words all commodities, whether principal or subsidiary, produced in one industry are made by the same process and therefore require the same input structure. (2)commodity technology assumption where it is assumed that technological processes depend on the nature of the individual commodities produced; and therefore those inputs are determined not by the industry which absorbs them but by the commodity into they enter. In a $commodity \times commodity$ table both rows and columns represent

the commodity group sectors. If the secondary product of an industry group along with the inputs are transferred to the industry group where they are the principal products, the resulting table is a *commodity* × *commodity* input-output table under the industry-technology assumption. For the present purpose of analysis, *commodity* × *commodity* input-output table has been selected. Thus, the term input-output table will now indicate *commodity* × *commodity* matrix under the industry technology assumption. This is preferred over other tables as it is more suitable for the analysis because of two reasons– firstly, here the purpose is to investigate the impact of production change on environmental water pollution and final demand category is one of the major component which tend to change the level of output. The demand is basically created for commodity groups and not for the industry groups. The technological effect can best be captured from both the demand and supply side in *commodity* × *commodity* matrix. Further the basic equation of input-output theory, i.e.

$$X = (I - A)^{-1}F$$

hold only in the case of pure tables like the one specified by the *commodity* × *commodity* table. Secondly, highly polluting industries are identified on the basis of certain commodities or group of commodities. The type of data available for environmental pollution provide the information which is in most cases specific to commodity not for the whole industry.

3.2 Comparability of the Indian Input-Output Table

As already mentioned 1983-84, 1989-90, 1993-94 I-O tables have been used in this study. Therefore overall value of research depends upon the comparability of these tables. In this section an attempt has been made to discuss the issue of comparability of the Indian input-output tables; identify those factors which tend to reduce the

comparability of these tables and explain the adjustments that were necessary to make all tables consistent with each other for comparison.

First it should be noted that all input-output tables are constructed at the current prices. Before we use these tables for the environmental analysis, they should be converted to the common base. Hence, first adjustment made to them was the conversion of all the tables to a constant base. This is essential because when environmental repercussions are calculated on the basis of current prices, it is possible that environmental coefficient give under-estimated value and thereby overall results may give misleading picture. Thus, all the input-output tables have been converted to a common base.

For the purpose of the present study, the 1983-84 and 1989-90 tables have been converted to the 1993-94 factor prices. 1993-94 year is chosen, because it is the most recent year for which the input-output table is available. The analysis in terms of most recent year is more meaningful. Also, the price deflators required for the conversion of base, were available for most of the sectors in this year.

The second adjustment was made in terms of aggregation of sectors. For the purpose of the present study, original 115 sector input-output table has been aggregated into 56 sectors. These sectors are formed on the basis of their environmental consequences and also on economic rationale. All newly formed 56 aggregated sector classification is given in appendix 3.1.

It is clear from the table that all efforts have been made to form a separate category for highly polluting industries so that their environmental consequences on the whole economy are known separately. Number of sectors had to be reduced from 115 to 56 because of the non-availability of pollution coefficients for some of the sectors. Those sectors that have less or no pollution potential have been given uniform treatment separately or collectively with other sectors. In some of the sectors price indices were incomplete or not available. Such sectors have been merged with those sectors for which price indices were available. For instance, sector 2* (dairy products and animal

services) of our classification is made by clubbing sector 18 (milk and milk products) and sector 19 (animal services) of CSO classification. This was done because necessary information related with price indices were not available for animal services sector.

CMIE price indices have been used to rebase the input-output tables. But these indices are available only for primary and manufacturing sector commodities. CMIE price indices are not available for service sector. The price inflators for service sector have been calculated from the value added figures of service sector published in National Accounts Statistics (CSO). Thus, sectorization for service sector was performed in such a manner so that it became consistent with the NAS classification for the service sector.

In aggregated 56 sector classification (Appendix 3.1), first 8 sectors represent primary production, next 43 sectors correspond to manufacturing activities and last 5 sectors deal with tertiary activities. In primary sectors, sector 1 of our classification represent agriculture products, two with animal husbandry, one with forestry and fishing, remaining four represent the mining activities. Secondary sectors correspond to all types of industries that have been categorized according to their output. Tertiary activities include services like construction, electricity, gas, water supply, railway transport, other transport, storage and warehousing, communication, trade, hotels and restaurants, banking, insurance, ownership of dwellings, education, medical and health and other services. All these service sector have been aggregated into 5 categories, namely construction, electricity, gas and water supply, transport services and other services.

The original input-output table consists of six categories of final demand viz. private fixed consumption expenditure (PFCE); government fixed consumption expenditure (GFCE); gross fixed capital formation (GFCF); change in stocks (CIS); exports (EXP); and imports (IMP). For the purpose of the present study, GFCF and CIS have been merged into one category comprising the combined sector of gross investment (GI). This was done to analyze the effects of gross investment rather than its two components separately.

Now for the purpose of the present study 56 sectors are available and the final demand category has five components– PFCE; GFCE; GI; EXP and IMP. Henceforth, whenever sector number will be used, it would imply these aggregated sectors; and the final demand category will refer to these five categories only.

Since three input-output tables viz. 1983-84, 1989-90 and 1993-94 have been used in this study and 1993-94 base has been selected. Thus, first two tables have been inflated at the 1993-94 prices. The inflators have been developed for the entire row. CMIE (Economic Intelligence Service, 1989, 1991, 1993 & 1994) price indices have been used for this purpose. CMIE provides wholesale price indices for a wide range of primary and manufacturing products. This formed the main source of data to perform inflation exercise. As mentioned earlier price indices for services were not available, thus, value added figures of the NAS have been used to develop the inflation variables.

CMIE gives both commodity wise index and also the weights of each commodity group. The index number for a particular sector is obtained on the basis of these assigned weights. For instance the index number for sector 1 (agriculture products) is the weighted average of all the commodities comprising food product sector.

Now the price inflators for a particular sector is calculated by dividing the index number of the sector in base year with the index number of sector in a year for which base need to be converted. For instance in the case of agriculture products the index number for 1993-94 is 294.8 and for 1989-90 184.8 , thus, price inflators for agriculture products in 1989-90 comes to around 1.6. This value has been multiplied by all the entries along the agriculture product row of the 1989-90 current price table to convert them to 1993-94 prices. For other sectors also price inflators have been calculated in a similar fashion.

For service sectors price inflators are calculated on the basis of value added (GVA) figures of the NAS. The gross value added figures for a sector is available both at current and at constant prices (CSO). The index for a sector is calculated by dividing the GVA of a sector at current prices by the GVA of the same sector at constant prices. This

exercise has been performed for all the sectors and for all the years. Now the price inflator is calculated in the same manner as done in manufacturing sector, that is, by dividing the index number of a sector in base year with the index number of the same sector in a year for which conversion is required.

Finally, the entire row has been multiplied by the term by which the particular row has to be inflated. This exercise has been performed for all the sectors. Coefficients are calculated on the basis of inflated output by dividing the output through entire column.

In this way both inter-industry and final demand matrix has been adjusted with the common base.

3.3 Water Pollution Data

As already mentioned in earlier chapters that Leontief's augmented model of environmental repercussions has been used for the present study. Under this model the regular input-output table is extended to cover environmental effects into the system. This has been done by introducing the additional rows for each pollutant and for all the sectors. Present study introduces 36 different organic, inorganic and toxic pollutants. Thus, resulting environment pollution flow matrix would be of (36×56) size. To complete the matrix of this size is not a simple task as no environmental data base exist in India that cover industrial pollution for all the sectors. Thus, this matrix is formed by collecting the data from different secondary sources. However, the main sources of data for this purpose have been Central Pollution Control Board (CPCB) and Uttar Pradesh State Pollution Control Board (SPCB). In addition to this some of the data gaps have been filled by other publications [Manivasakam (1997), Nemerow (1978) , Goel and Sharma (1996)].

In the augmented model of environmental repercussions, pollutants are entered in physical terms, under the linearity assumption. This implies that pollutants varies

linearly with output. Thus, the additional rows created for different pollutants represent the pollution output of the corresponding industry that varies with the output. In this way (36×56) environment pollution flow matrix is formed. Clearly, not all the pollutants are discharged by all the industries, thus, resulting matrix will have both zero and non-zero characters. Most of the data requirement for this matrix is met by CPCB and SPCB. Central Pollution Control Board (CPCB) has industry specific environmental accounting documents of different industrial units, which clearly mentions the pollution characteristics, load factors and abatement cost alternatives. This accounting is done for most of the highly polluting industries. In addition to this, CPCB has some documents that provide guidelines to different industries regarding pollution discharge, treatment and disposal. Besides, some of the database has been prepared by the SPCB survey of industries. In Uttar Pradesh SPCB has conducted a survey of highly polluting industries. This provides detailed information regarding effluent characteristics, quality and abatement status of large and medium size 450 industrial units.

For the present purpose of the study, the data set for livestock products, hydrogenated and other edible oils, food products, synthetic textile, jute, paper, leather, rubber, petroleum products, heavy chemicals, fertilizer, pesticide, paints, drugs, soaps, cosmetics and glycerine, other non-metallic mineral products, iron and steel, non-ferrous basic metals, batteries, machine tools, other non-electrical machinery and electricity have been taken from the CPCB data source. The data for dairy products, tobacco, metal products, hand tools, tractors and agriculture implements, industrial machinery, motor vehicles, scooters, transport equipment, watch and clocks are taken from SPCB data source.

Apart from this there are some polluting industries left which could not be covered by either of the aforesaid sources or in some cases information provided by the CPCB and SPCB was incomplete. Data for those industries has been taken from Manivaskaram (1997) and Nemerow (1978). These industries include coal and lignite, beverages, cotton textile, woolen textile, plastic, fertilizer and synthetic fibers. Still

there are some industrial categories left for those any of the data was not available. Such industries include metallic minerals, non-metallic minerals, silk textile, structural clay products, cement, electrical and electronic equipment, transport services. The data for these industrial categories has been substituted from the general standard figures [CPCB(19), Goel and Sharma (1996)].

Finally there are some industrial categories which either do not emit any liquid effluent or it is negligible. Zero pollution value has been taken for such industries, which include agriculture products, wooden products, printing and publishing, construction, gas & water supply and other services.

Initially pollution output data was obtained as a function of physical output of the different sectors. In this case units of the different sectors were different. In order to make them consistent with each other, it was necessary to convert them on common scale. Thus, environment matrix was to be expressed in value terms. Moreover, input-output tables were available in value terms. It was done in such a way so that the pollution output became the function of the value of output instead of physical output.

In order to solve this problem absolute prices have been used for different sectors of the input-output table. These prices are derived from the 'Annual Survey of Industries' (ASI, 1993-94). ASI provides data for products and by-products, in value as well as in quantitative terms. In deriving such prices we did not face any problem as information was available at 3-4 digit industrial classification. In this way prices for all the sectors are easily calculated for all the manufacturing sectors. For some service sectors such as transport services, prices were calculated from the information given in Statistical Abstract (CSO, 1997).

As mentioned earlier all analysis has been done at 1993-94 prices. Therefore, environmental matrix is also converted at 1993-94 prices. This was done by multiplying the physical output with the monetary value of output. Then, it was multiplied by one lakh because in the present analysis intermediate and final demand categories are also expressed in terms of one lakh rupee.

Finally, pollution output flow matrix is constructed both for before and after abatement of pollution. These two matrices remain same for all the years. This has been done under the assumption that environment technology remains same and does not change frequently. Within 10 years time period it has remained more or less unaltered. Survey of most of the industries also reveals the same fact. It has been verified from some of the highly polluting sectors that the effluent treatment technology has not changed much during past several years. Thus, the after abatement pollution characteristics have remained more or less same during last several years. In India most of the effluent treatment plants (ETP) were installed at the time when industry came into existence. In a very few cases there have been changes in environment technology. In some of the industrial units ofcourse there have been updates but because of the unavailability of the data we had to resort this assumption.

In the following chapters analysis would be based on the above mentioned data set.

Appendix 3.1

Aggregation Scheme of Different Sectors of the Input-Output Table[1]

1. **Agriculture Products**—Paddy, wheat, other cereals, pulses, sugarcane, jute, cotton, tea, coffee, rubber and other crops.
2. **Dairy Products and Animal Services***—Milk and milk products and animal services.
3. **Other Livestock Products***— Other livestock products.
4. **Forestry, Logging and Fishing**— Forestry, logging and fishing.
5. **Coal and Lignite**— Coal and lignite mining.
6. **Crude Petroleum and Natural Gas**— Crude petroleum and natural gas.
7. **Metallic Minerals**— Iron ore, copper ore, manganese ore, bauxite and other metallic minerals.
8. **Non-Metallic Minerals**— Limestone, mica and other non-metallic minerals.
9. **Sugar***— Sugar, khandsari and boora.
10. **Hydrogenated and Edible Oils**— Hydrogenated oil and edible oils.
11. **Food Products***— Tea and coffee processing and miscellaneous food products.
12. **Beverages***— Distilling, rectifying and blending of spirits, wines, beer, malt, liquors, other malt country liquor, toddy, manufacture of aerated drinks, aerated natural flavored syrup, synthetic flavored syrup, fruit juices and beverages n.e.c.
13. **Tobacco Products**—Tobacco stemming, redrying, grading etc and manufacture of bidi, cigars, cigarette, cheroots, cigarette tobacco, chewing tobacco, zarda and snuff.
14. **Cotton and other Textile Products***—Cotton ginning, cleaning and baling, spinning, weaving and finishing of cotton textiles in mills and power looms, printing, dyeing and bleaching of cotton textiles and cotton textiles n.e.c.

[1]* indicates Highly Polluting Sectors.

15. **Woolen Textiles***—Wool cleaning, baling and pressing, wool spinning, weaving etc. (hand loom, power looms and mills), dyeing, bleaching and manufacture of woolen blankets, shawls, felts and others.

16. **Silk Textiles***—Spinning, weaving, finishing, printing, dyeing and bleaching of silk textiles.

17. **Art Silk and Synthetic Fiber Textiles***—Spinning, weaving and finishing of synthetic fibers, rayons, nylons etc., printing, dyeing and bleaching of synthetic textiles, other silk and synthetic fiber textiles.

18. **Jute, Hemp Mesta Textiles***—Pressing, baling, spinning and weaving, finishing of jute, mesta, hemp and other coarse fiber, dyeing, printing and bleaching of jute textiles, manufacture of jute bags and other jute textiles.

19. **Wood and Wooden Products**— Wooden, bamboo, cane furniture and fixtures and repair of such furniture, manufacture of veneer, plywood and their products, sawing and planing of wood, container made of wood, cane, bamboo, reed etc.,structural wooden goods such as beams, posts etc., wooden industrial goods, cork and cork prcoduts and miscellaneous wood, bamboo and cane products.

20. **Paper and Paper based products***—Manufacture of machine made and made pulp, paper and paper board including newsprint, containers and boxes of paper and paper board, miscellaneous pulp products, paper and paper board articles.

21. **Printing and Publishing**—Printing, publishing and allied activities.

22. **Leather Footwear**—Leather footwears all types.

23. **Leather and Leather Products***—Tanning, curing, finishing, embossing and japanning of leather, manufacture of wearing apparel and consumer goods of leather and substitutes of leather, scrapping curving and tanning, bleaching, dyeing of fur and other pelts, manufacture of wearing apparel, rugs and other articles of fur and pelts.

24. **Rubber Products***—Rubber lyres and tubes for motor vehicles, tractors, aircraft, scooters, motor cycles and cycles and other rubber and plastic footwear,

rubber surgical and medical equipment, rubber contraceptives, rubber pipes, balloons, rubber industrial and domestic goods and miscellaneous rubber products.

25. **Plastic Products***—Plastic moulded goods such as containers, sheets, nets, cords, polythene bags, spectacles frames, industrial accessories, domestic goods and miscellaneous plastic products.
26. **Petroleum Products***—Products of petroleum refineries.
27. **Coal Tar Products***—Coke and other coal tar products.
28. **Organic-Inorganic Heavy Chemicals***—Basic heavy inorganic chemicals and basic heavy organic chemicals.
29. **Fertilizers***—Inorganic, organic, mixed and other fertilizers.
30. **Pesticides***—Insecticides, fungicides, weedicides and pesticides formulations.
31. **Paint Varnishes and Lacquers***—Paints, varnishes, lacquers, dyestuffs, waxes and polishes.
32. **Drugs and Medicines***—Drugs and medicines - allopathic, ayurvedic, unani, homeopathic and others.
33. **Other Chemicals***—Soaps, perfumes, cosmetics, toothpaste, soap in any form and other toilet aids, glycerine and detergents, inedible vegetable oils including solvent extracted oils, animal oils and fats, matches, explosives, ammunition, safety fuses, fire-works, photochemical materials, sensitized films and paper, fine chemicals, drug and dye intermediaries, glue and galatine, shellac, synthetic sweeteners, textile chemical auxiliaries and other chemical products.
34. **Synthetic Fibers and Resins***—Turpentine, resin, synthetic resin plastic materials and synthetic fibers like celluloid nylon,terylene and miscellaneous products of fermentation industries other than alcohol.
35. **Structural Clay Products**—Structural clay products such as fire bricks, refractories, tiles and others.
36. **Cement**—Cement.
37. **Other Non-Metallic Mineral Products***—Manufacture of glass and glass products, earthenware and pottery, chinaware, sanitary ware, porcelain-ware,

insulators, lime and plaster, mica products, structural stone goods, stoneware, stone dressing and crushing, earthen and laster statues and products, asbestos cement and its products, slate products, cement and concrete products, abrasives, graphite products, mineral wool, silica products and other non-metallic mineral products.

38. **Iron-Steel Industries and Foundries***—Iron and steel, special steel and ferro-alloys, iron and steel castings and forgings, iron and steel structural, pipes, plates, wire drawings, tools and others.

39. **Non-Ferrous Basic Metals***—Melting, refining, rolling into basic forms, wire drawings etc from non-ferrous basic metals and alloys.

40. **Metal Products including Hand Tools**–Hand tools, hardwares and miscellaneous metal products.

41. **Tractors and Agriculture Implements**– Tractors and other agriculture implements.

42. **Industrial Machinery**–Industrial machinery all types.

43. **Machine Tools and Other Non-Electrical Machinery**– Machine tools, office computing and accounting machinery and other machine tools.

44. **Electrical and Electronic Equipments**–Electrical industrial machinery, electrical cable wires, electrical appliances,communication equipments, other electrical machinery and electronic equipments.

45. **Batteries**–Batteries and dry cells.

46. **Ships and Boats**–Ships and Boats.

47. **Rail Equipments**– Rail equipments all types.

48. **Motor Vehicles and Scootors**–Motor Vehicles, motor cycles and scootors.

49. **Cycle, Rickshaw and Other Transport Equipments**– Cycle, rickshaw and bicycle etc.

50. **Watches and Clocks**– Watches and clocks.

51. **Miscellaneous Manufacturing**–Other miscellaneous manufacturing, manufacture of surgical, medical instruments, water meters, regulating devices, photographic and optical goods and minting coins etc.

52. **Construction**–Construction.

53. **Electricity***–Generation and Transmission (thermal power plants and hydro electricity).

54. **Gas and Water Supply**– Gas and water supply.

55. **Transport services**–Railway and other transport services.

56. **Other Services**– Storage and warehousing, communication, trade, hotels and restaurants, banking, insurance, ownership of dwellings, education and research, medical and health, other services, public administration and defense.

Appendix 3.2

List of 36 Organic, Inorganic and Toxic Pollutants

In the analysis, effluent quantity (1) will be expressed in thousand cu.m. and other pollutants (2-36) in tons. The immediate description will be given wherever any other unit will be used (e.g. percentage). In the case of pollution intensity, these pollutants will be expressed in terms of thousand cu.m. or tons of pollution generation, per lakh rupees of output.

1. Effluent quantity
2. Total Suspended Solids
3. Total Dissolved Solids
4. Total Solids
5. Dissolved Fixed Solids
6. Total Volatile Solids
7. Biological Oxygen Demand (BOD)
8. Chemical Oxygen Demand (COD)
9. Oil and Greases
10. Ammonical Nitrogen
11. Total Kjedahl nitrogen (TKN)
12. Total Nitrogen
13. Organic Nitrogen
14. Nitrate Nitrogen
15. Iron
16. Chlorides
17. Zinc
18. Sulphate
19. Chromium
20. Phenolic Compounds
21. Lead
22. Cyanides
23. Phosphate

24. Mercury
25. Hexavalent chromium
26. Fluorides
27. Calcium
28. Copper
29. Cadmium
30. Sodium
31. Nickel
32. Magnesium
33. Potassium
34. Aluminium
35. Total Acids
36. Dissolved Phosphate

Chapter 4

Water Pollution Intensity

In the last few decades industrial pollution has increased to such an extent that it has become a cause of great concern. Over a period of time, the quality of land, air and water has distinctly degraded. The pollution contributed by the industrial effluents has been the dominant source for the degradation of these resources. Industrial effluents contain chemicals and biological matter of diversified nature. Polluted water, thus, has deficient level of dissolved oxygen as a result of high biological oxygen demand (BOD) and chemical oxygen demand (COD). Apart from this, other toxic chemicals and metals present in the water adversely affect the health of human beings and ecosystems.

The analysis that follows attempts to calculate the magnitude of pollution intensity by the different producing as well as consuming units of the economy. The data on residual generation is compiled in a meaningful way so as to link the waste generation with the economic sectors of the economy. It is of great importance for macro-economic policy to know that how changes in the economic activities cause changes in the level of pollution. The interdependence between different sectors of the economy plays a crucial role in determining the level of pollution. Therefore, while applying the policy measures to the generation of residuals, these interdependencies must be taken into account.

The following analysis would highlight the issue of how economic-interdependence determine the level of pollution. All the producing and consuming units are responsible for the pollution generation. However, they all vary in rate and magnitude of residual generation. The empirical analysis is designed to investigate following two main issues–

(1) To find out the status and pollution potential of different sectors of the economy.

(2) To examine the relationship between the final demand categories and the amount of residual generation.

For the present purpose 'direct' as well as 'direct plus indirect' pollution intensity has been analyzed. Section 4.1 discusses the direct pollution intensity of the different sectors of the economy. In section 4.2, direct and indirect water pollution coefficients are derived. In section 4.3, a comparison is made between direct and direct plus indirect water pollution coefficients. Finally in section 4.4, the relationship of pollution intensity with different categories of final demand has been analyzed. The summary of results is presented in the last section.

4.1 Direct Pollution Intensity

This section aims to describe the direct pollution intensity of the different sectors in the input-output table. Pollution intensity describes the generation of pollution per unit of output. For the present purposes, units of the physical pollution output have been expressed in terms of the money value of economic sectors. Thus, these units indicate generation of pollution in tons per lakh rupees of output. Clearly, this part of the matrix will have physical quantity in terms of money value. The pollution figures were originally given in terms of cu.m./kilograms per ton of quantity output. The pollution matrix is prepared by converting the quantity output in money terms. For instance, dairy product (2) industry in terms of quantity generates 78 cu.m. of effluents per ton of output. The per ton price for dairy product (2) is rupees 20655.

These prices are then divided by the effluent quantity i.e. 78 cu.m. Thereafter it is multiplied by the rupees one lakh. The resulting figure gives effluent quantity per lakh rupees of output. Similarly, this exercise is repeated for all the sectors and for all the pollutants. Table 4.1 describes the direct pollution intensity of the different sectors of the economy. These direct coefficients are given for the aggregated 56 sectors and 36 different organic, inorganic and toxic water pollutants. The complete list of sectors and pollutants is given in appendices 3.1 and 3.2.

It is clear from the table 4.1 that some of the sectors are non-polluting and hence generate zero-pollution. These are the non-polluting sectors of the economy. Out of 56 sectors, 6 sectors such as agriculture (1), forestry, logging and fishing (4), printing and publishing (21), construction (52), gas and water supply (54), and other services (56), have been considered under the non-polluting category. The next category is of 'highly polluting industries'. Twenty eight sectors of the input-output table fall under this category.[1] These industries have been characterized as highly polluting in all the policy documents of the Government and Central Pollution Control Board's list of highly polluting industries. The pollution generated by these industries is voluminous as well as highly concentrated. Consequently, they generate high pollution load on the environment.

The rest of the sectors in the input-output table are low or moderately polluting. They include coal and lignite (5), crude petroleum and natural gas (6), metallic minerals (7), non-metallic minerals (8), tobacco products (13), wood and wooden products (19), leather footwear (22), coal tar products (27), structural clay products (35), cement (36), metal products including hand tools (40), tractors and agriculture implements (41), industrial machinery (42), machine tools and other non-electrical machinery (43), electrical and electronic equipment (44), ships and boats (46), rail equipment (47), motor vehicles and scooters (48), cycle, rickshaw and other transport equipment (49),

[1] Although there are only 17 industries listed in the category of highly polluting industries but pollution data was available on commodity groups thus, we have categorized them into 28 highly polluting sectors.

Table 4.1: **Direct Water Pollution Coefficients**

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0.314	0.314	0.317	0.04	0.653	0.345	0	0	0	0	0	0
3	0.042	0.042	0.049	0.004	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	2.287	2.287	0	0	0	0	0	0	0	0	0	0
6	0.376	0.376	0	0	0	0	51.41	10.282	0	0	0	0
7	0.012	0.012	0.001	0.001	0	0	0	0	0	0	0	0
8	0.081	0.081	0.008	0.008	0	0	0	0	0	0	0	0
9	0.016	0.016	0.01	5E-4	0.036	0.002	0	0	0	0	0	0
10	0.007	0.007	0.078	0.001	0.047	0.029	0	0	0	0	0	0
11	0.021	0.021	0.006	0.001	0	0	0	0	0	0	0	0
12	0.173	0.173	10.876	0.152	6.146	0.086	0	0	0	0	0	0
13	0.011	0.011	0.001	0.001	0.007	0.007	0	0	0	0	0	0
14	0.079	0.079	0.081	0.008	0.158	0.015	0.239	0.023	0.136	0.013	0	0
15	0.051	0.051	0.053	0.005	0.102	0.01	0.155	0.015	0.088	0.009	0	0
16	0	0	5E-06	5E-06	0	0	0	0	0	0	0	0
17	0.299	0.299	0	0	0.432	0.072	0.466	0.078	0	0	0.152	0.025
18	0.009	0.009	2E-04	1E-05	0	0	0	0	0	0	0	0
19	0.001	0.001	8E-05	8E-05	0	0	0	0	0	0	0	0
20	1.001	1.001	0.765	0.035	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0.006	0.006	0.001	0.001	0	0	0	0	0	0	0	0
23	0.026	0.026	0.097	0.037	0.444	0.09	0.541	0.109	0	0	0	0
24	0.094	0.094	0.037	0.009	0.216	0.197	0	0	0	0	0	0
25	0.004	0.004	0.081	0	0.301	0.002	0	0	0.221	0.001	0	0
26	0.014	0.014	0	0	0	0	0.115	0.023	0	0	0	0
27	0.029	0.029	0.003	0.003	0	0	0	0	0	0	0	0
28	0.19	0.189	0.434	0.134	6.795	0.374	0	0	0	0	0	0
29	0.541	0.541	0.399	0.054	1.703	0.231	0	0	0	0	0	0
30	0.002	0.002	0.002	2E-04	0	0	0	0	0	0	0	0
31	0.001	0.001	0.03	0.016	0.016	0.008	0.043	0.022	0	0	0.019	0.01
32	1.76	1.76	1.287	0.109	0	0	0	0	0	0	0	0
33	0.002	0.002	8E-05	6E-05	0.012	0.009	0.014	0.011	0	0	0	0
34	0.552	0.552	0	0	0.798	0.133	0.862	0.144	0	0	0.28	0.047
35	0.003	0.003	3E-04	3E-04	0	0	0	0	0	0	0	0
36	0.017	0.017	0.002	0.002	0	0	0	0	0	0	0	0
37	0.026	0.026	0.012	0.001	0	0	0	0	0	0	0	0
38	0.078	0.078	0.003	5E-05	0.049	0.011	0	0	0	0	0	0
39	0.013	0.013	9E-05	9E-05	0	0	0	0	0	0	0	0
40	0.004	0.004	0.001	0	0.006	0.005	0	0	0	0	0	0
41	2E-04	2E-04	5E-05	1E-05	3E-04	2E-04	0	0	0	0	0	0
42	2E-05	2E-05	5E-06	1E-06	3E-05	3E-05	0	0	0	0	0	0
43	0.001	0.001	8E-05	8E-05	0	0	0	0	0	0	0	0
44	1E-06	1E-06	1E-07	1E-07	0	0	0	0	0	0	0	0
45	0.003	0.003	3E-04	3E-04	0	0	0	0	0	0	0	0
46	4E-05	4E-05	3E-06	3E-06	2E-05	2E-05	0	0	0	0	0	0
47	1E-04	1E-04	1E-05	1E-05	9E-05	9E-05	0	0	0	0	0	0
48	0.005	0.005	3E-04	3E-04	0.003	0.003	0	0	0	0	0	0
49	0.059	0.059	0.012	0.004	0.053	0.052	0	0	0	0	0	0
50	0.282	0.282	0.027	0.019	0.03	0.028	0	0	0	0	0	0
51	0.003	0.003	3E-04	3E-04	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0.41	0.41	0.6	0.6	0.072	0.072	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	4E-04	4E-04	4E-05	4E-05	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

BT- Before Abatement Values, AT- After Abatement Values. For sectors and pollutants specification please see appendices 3.1 and 3.2

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0.203	0.012	0.54	0.069	0.035	0.002	0	0	0	0	0	0
3	0.111	0.004	0.179	0.007	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	4E-04	4E-04	0.003	0.003	1E-04	1E-04	0.001	0.001	0.001	0.001	0	0
8	0.002	0.002	0.02	0.02	0.001	0.001	0.004	0.004	0.008	0.008	0	0
9	0.016	3E-04	0.062	0.004	8E-05	8E-05	0	0	2E-04	1E-05	0	0
10	0.05	0.002	0.112	0.005	0.032	1E-04	0	0	0	0	0	0
11	0.031	0.001	0.053	0.001	4E-04	7E-05	0	0	0	0	0	0
12	6.905	0.097	0	0	0	0	0.169	0.002	0	0	0	0
13	2E-04	2E-04	0.001	0.001	8E-05	8E-05	0	0	0	0	0	0
14	0.02	0.002	0.031	0.02	0	0.001	0	0	0	0	0	0
15	0.013	0.002	0.02	0.013	0	0.001	0	0	0	0	0	0
16	2E-06	2E-06	1E-05	1E-05	5E-07	5E-07	3E-06	3E-06	5E-06	5E-06	0	0
17	0.179	0.03	0.469	0.078	0	0	0	0	0	0	0	0
18	1E-03	1E-04	0.002	3E-04	1E-04	2E-05	0	0	0	0	0	0
19	2E-05	2E-05	2E-04	2E-04	8E-06	8E-06	4E-05	4E-05	8E-05	8E-05	0	0
20	0.295	0.025	1.119	0.325	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	2E-04	2E-04	0.001	0.001	7E-05	7E-05	0	0	0	0	0	0
23	0.045	0.005	0.116	0.013	0	0	0	0	0	0	0	0
24	0.212	0.005	0.437	0.023	0	0	1E-03	7E-05	0	0	0.002	9E-05
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0.045	4E-04	0.07	0.002	0.001	1E-04	0.005	0.001	0	0	0	0
27	0.001	0.001	0	0	3E-04	3E-04	0.001	0.001	0	0	0	0
28	7.416	0.04	17.548	0.111	0.001	0.001	0	0	0	0	0	0
29	0.151	0.019	0.173	0.022	0.273	0.005	0.214	0.027	0	0	0	0
30	0.004	0.001	0.009	0.002	0	0	0	0	0	0	0	0
31	0.015	0.006	0.082	0.039	0.002	0.001	0	0	0	0	0	0
32	0.839	0.104	3.523	0.468	0.083	0.041	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0
34	0.331	0.055	0.866	0.144	0	0	0	0	0	0	0	0
35	1E-04	1E-04	0.001	0.001	3E-05	3E-05	0	0	3E-04	3E-04	0	0
36	5E-04	5E-04	0.004	0.004	2E-04	2E-04	0.001	0.001	0.002	0.002	0	0
37	0.001	3E-04	0.002	0.001	0	0	0	0	0	0	0	0
38	0.054	0.002	0.112	0.004	0	0	0.062	0.002	0	0	0	0
39	0	0	0	0	4E-05	4E-05	0	0	0	0	0	0
40	9E-05	7E-05	0.001	0.001	0	0	0	0	0	0	0	0
41	4E-06	3E-06	4E-05	4E-05	0	0	0	0	0	0	0	0
42	4E-07	3E-07	4E-06	4E-06	0	0	0	0	0	0	0	0
43	4E-06	4E-06	1E-05	1E-05	0	0	0	0	0	0	0	0
44	4E-08	4E-08	3E-07	3E-07	1E-08	1E-08	7E-08	7E-08	1E-07	1E-07	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0
46	6E-07	6E-07	4E-06	4E-06	3E-07	3E-07	0	0	0	0	0	0
47	2E-06	2E-06	1E-05	1E-05	1E-06	1E-06	0	0	0	0	0	0
48	7E-05	7E-05	5E-04	5E-04	4E-05	4E-05	0	0	0	0	0	0
49	0.003	0.001	0.012	0.008	0	0	0	0	0	0	0	0
50	0.023	0.014	0.047	0.041	0	0	0	0	0	0	0	0
51	8E-05	8E-05	0.001	0.001	3E-05	3E-05	1E-04	1E-04	3E-04	3E-04	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0.053	0.053	9E-03	9E-03	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	1E-05	1E-05	1E-04	1E-04	4E-06	4E-06	2E-05	2E-05	4E-05	4E-05	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

Poll.→	13		14		15		16		17		18	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0.05	0.01	0	0	0	0	1.706	0.341
6	0	0	0	0	0	0	26.28	5.256	0	0	0.296	0.059
7	0	0	0	0	4E-05	4E-05	0.012	0.012	6E-05	6E-05	0.012	0.012
8	0	0	0	0	2E-04	2E-04	0.081	0.081	4E-04	4E-04	0.081	0.081
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0.732	0.01	0	0	0.76	0.011
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0.033	0.003	6E-05	6E-06	0	0
15	0	0	0	0	0	0	0.021	0.002	4E-05	4E-06	0	0
16	0	0	0	0	2E-07	2E-07	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0.001	2E-04	0	0	0	0
19	0	0	0	0	2E-06	2E-06	0.001	0.001	0	4E-06	0	0.001
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0.142	0.029	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0.131	0.001	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0.055	0.007	0.035	0.005	0	0	0.041	0.005	0.003	0	0.482	0.061
30	0	0	0	0	0	0	0.055	0.001	0	0	0.004	0.001
31	0	0	0	0	0.404	0.211	0	0	0.111	0.058	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	7E-08	1E-09	0	0	0	0	0.003	4E-05
34	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	1E-05	1E-05	0	0	0	0	0	0
36	0	0	0	0	5E-05	5E-05	0	0	0	0	0	0
37	0	0	0	0	4E-05	2E-07	0	0	0.001	4E-06	0	0
38	0	0	0	0	0	0	0.002	7E-05	0	0	0	0
39	0	0	0	0	3E-05	3E-05	0	0	2E-05	2E-05	0.039	0.039
40	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	3E-07	3E-07	0	0	3E-08	3E-08	0	0
44	0	0	0	0	4E-09	4E-09	1E-06	1E-06	7E-09	7E-09	1E-06	1E-06
45	0	0	0	0	0	0	0	0	1E-05	1E-05	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	8E-06	8E-06	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	1E-06	1E-06	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

Poll.→	19		20		21		22		23		24	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	2E-05	2E-05	1E-05	1E-05	1E-06	1E-06	2E-06	2E-06	6E-05	6E-05	1E-07	1E-07
8	2E-04	2E-04	8E-05	8E-05	8E-06	8E-06	2E-05	2E-05	4E-04	4E-04	8E-07	8E-07
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	4E-04	3E-05	5E-06	5E-07	0	0	0	0	0	0	0	0
15	2E-04	2E-05	3E-06	3E-07	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	2E-06	2E-06	0	8E-07	0	8E-08	0	2E-07	0	4E-06	8E-09	8E-09
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0.004	0.001	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	2E-04	4E-06	0	0
27	0	0	1E-04	1E-04	0	0	6E-06	6E-06	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0.004	0.001	0	0	0	0	0	0	0.004	0.001	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0
31	0.005	0.002	0	0	0.009	0.005	1E-04	6E-05	0	0	0.008	0.004
32	0	0	0.002	0.001	2E-04	2E-05	2E-04	2E-05	0.009	0.001	0	0
33	0.002	4E-06	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	1E-05	3E-06	0	0	0	0	0	0
38	0	0	0.011	4E-04	0	0	0.002	3E-05	0	0	0	0
39	1E-07	1E-07	0	0	4E-07	4E-07	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	3E-09	3E-09	1E-09	1E-09	0	0	0	0	7E-09	7E-09	0	0
45	0	0	0	0	3E-07	3E-07	0	0	0	0	5E-08	5E-08
46	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

Poll.→ Sec.↓	25		26		27		28		29		30	
	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0.217	0.043	0	0	0	0	0	0
6	0	0	0	0	2.703	0.541	0	0	0	0	13.431	2.686
7	1E-06	1E-06	2E-05	2E-05	0	0	4E-05	4E-05	2E-05	2E-05	0	0
8	8E-06	8E-06	2E-04	2E-04	0	0	2E-04	2E-04	2E-04	2E-04	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	8E-08	8E-08	0	2E-06	0	0	0	2E-06	0	2E-06	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	1.104	0.139	0.059	0.007	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0.01	0.003
31	0	0	0	0	0.003	0.002	0.004	0.002	0.001	0	6E-04	3E-04
32	2E-04	2E-05	0	0	0	0	0	0	0	0	0	0
33	2E-05	2E-07	0	0	8E-04	1.00E-05	0	0	0	0	0.002	3E-05
34	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	3E-06	5E-07	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	2E-05	2E-05	0	0	3E-07	3E-07	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	3E-09	3E-09	0	0	4E-09	4E-09	3E-09	3E-09	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

Poll.→	31		32		33		34		35		36	
Sec.	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0.126	0.025	0	0	0.039	0.008	1.066	0.213	0	0
6	0	0	0.87	0.174	0	0	0	0	0	0	0	0
7	4E-05	4E-05	0	0	0	0	0	0	0	0	0	0
8	2E-04	2E-04	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0.001	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1.761	0.025	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	0	2E-06	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0.003	3E-04
31	0.002	0.001	2E-04	8E-05	0	0	0.293	0.153	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	1E-05	2E-07	3E-07	4E-09	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	4E-09	4E-09	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0

watches and clocks (50), miscellaneous manufacturing (51), and transport services (55).

Thus, we may say that there are three categories of industries, viz. non-polluting, highly polluting and low/moderately polluting. In this section we have examined the pollution potential and pollution characteristics of each of these categories. These industries are classified as polluting and non-polluting on the basis of their pollution characteristics and pollution load on the economy. The effluent characteristics or composition greatly varies before and after treatment of effluents. The after abatement pollution characteristics and its load basically depend upon the level of abatement performed at the level of individual industries. It is the after abatement that pollution characteristics enter into the environment. The relative share of sectors in total is also important because it gives us an idea about the pollution potential of each sector. Thus, in this section, we have discussed the direct pollution intensity on the basis of three aspects, viz. change in composition of effluents before and after abatement, the relative share of sectors in total direct pollution and the share of highly polluting industries in total direct pollution. On the basis of these aspects we decide about the actual status of pollution in a particular sector/industry.

The direct pollution intensity of all the sectors is presented in summary table of 4.2. It can be seen that in the case of effluent quantity (1) the pollution intensity has been high (above 0.10) for sectors such as dairy (2), beverages (12), synthetic textile (17), paper (20), heavy chemicals (28), fertilizer (29), drugs (32), synthetic fiber (34) and electricity (53). It has crossed 0.90 only for coal and lignite (5), paper (20) and drugs (32). All these sectors fall under the highly polluting category.

The highly polluting sectors have high direct pollution intensity in the case of majority of the pollutants. For example the pollution intensity of suspended insoluble solids (2-6) is found to be high for dairy (2), beverages (12), cotton textile (14), leather (23), rubber (24), heavy chemicals (28), drugs (32), and electricity (53). In the case of biological and chemical oxygen demand (7-8) it has shown high intensity of above 0.10 tonnes per lakh rupees of output for the sectors such as drugs (32), paper (20), heavy

Table 4.2: **Summary–Direct Pollution Intensity**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-0.01	0.01-0.05	0.05-0.10	above 0.10
1	10, 16, 18, 19, 22, 25, 30, 31, 33, 35, 40-48, 51, 52, 54-56.	3, 7, 9, 11, 13, 23, 26, 27, 37, 39.	8, 14, 15, 24, 38, 49.	2, 5, 6, 12, 17, 20, 28, 29, 32, 34, 50, 53.
2	7-11, 13-19, 22, 24-27, 30, 33-49, 51, 55.	3, 20, 23, 31, 50.	29	2, 12, 28, 32, 53.
3	9, 13, 15, 25, 31, 33, 40-42, 46-48.	10, 14, 38, 50.	12, 17, 23, 49, 53.	2, 24, 28, 29, 34.
4		14, 15, 26, 31, 33.	17.	6, 23, 34.
5	25.		15.	14.
6		17, 31, 34.		
7	3, 7-11, 13-16, 18, 19, 24, 26, 27, 30, 31, 35-38, 40-44, 46-49, 51, 55.	2, 17, 20, 28, 29, 50.	12, 34.	32.
8	3, 7, 9-13, 16, 18, 19, 22, 26, 30, 35-49, 51, 55.	8, 14, 15, 23, 24, 29, 31, 50	2, 17, 53.	20, 28, 32, 34.
9	2-31, 35-56.	32.		
10	1-28,30-56.	29.		
11	all			
12	all			
13	all			
14	all			
15	7-30, 32-56.	5.		31.
16	14, 15-22, 24-56	7, 12, 23.	8.	6.
17	1-30, 32-56		31, 8.	
18	19, 30, 33, 44.	7, 12, 39.	"6,29,"	5.
19	all			
20	all			
21	all			
22	all			
23	all			
24	all			
25	all			
26	1-28, 30-56			29.
27	29, 31, 33.	5.		6.
28	all			
29	all			
30	30, 31, 33.			6.
31	all			
32	31.	5.		6.
33	33.	12		
34	5, 33.			31.
35	9.			5.
36	all			

Ranges indicate pollution quantity in terms of per lakh rupees of output. For sectors and pollutants specification, see appendices 3.1 and 3.2

chemical (28), and synthetic fiber (34). For the remaining pollutants, all sectors have generally shown low intensity pattern. In very few cases coal and lignite (5), crude petroleum (6), fertilizer (29) and paint varnishes (31) have generated high intensity. Table 4.2 shows that majority of the sectors have fallen in the low intensity range.

A close examination of the table reveals that in the case of direct water pollution coefficients highly polluting sectors have appeared in the high range for majority of the pollutants. Sectors such as dairy (2), beverages (12), textile (14,17), paper (20), leather (23), rubber (24), heavy chemicals (28), fertilizers (29), drugs (32), synthetic fiber (34) etc, have repeatedly been found with high intensity in the case of most of the pollutants.

This pattern of direct pollution intensity shows that though all highly polluting sectors generate substantial amount of pollution, the above mentioned sectors appear to be the most polluting. This would become more evident when we compare the relative share of each sector separately. The following subsection looks into the before and after abatement composition of effluents.

4.1.1 Composition of Effluents: Before and After Abatement

The before and after abatement direct pollution coefficients are given in table 4.1. The same coefficients are shown in terms of percentage for all the sectors of the input-output table in summary table 4.3. Even if pollution abatement is carried out in a thorough manner, some of it still remains which is ultimately discharged into the environment. This percentage of abatement is important because it ascertains the quality of environment through control at various channels or industries. The rate of abatement varies in the case of every industry and every pollutant. Here we examine the before and after abatement characteristics for all the sectors of the input-output table.

As regards the sectoral pattern of abatement, we find overall a high level of

Table 4.3: **Summary– Level of Pollution Abatement)**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-10%	10-30%	30-80%	above 80%
1	*No Change in quantity*			
2	7, 8, 13, 16, 19, 22, 27.	33, 50.	23, 24, 28, 31, 40-42, 49.	2, 3, 9-12, 14, 15, 18, 20, 25, 29, 30, 32, 37, 38.
3	13, 24, 46-50, 53.	33, 40-42,	2, 10, 31, 38.	9, 12, 14, 15, 17, 23, 25, 28, 29, 34.
4		33.	31.	6, 14, 15, 17, 23, 26, 34.
5				14, 15, 25.
6			31.	17, 34.
7	7, 8, 13, 16, 19, 22, 27, 35, 36, 43, 44, 46-48, 51, 55.	40-42.	30, 31, 37, 49, 50.	2, 3, 9-12, 14, 15, 17, 18, 20, 23, 24, 26, 28, 29, 32, 34, 38.
8	7, 8, 13, 16, 19, 22, 35, 36, 39, 41-44, 46-48, 51, 53, 55.	40, 50.	14, 15, 20, 31, 37, 49.	2, 3, 9-11, 17, 18, 23, 24, 26, 28-30, 32, 34, 38.
9	7-9, 13-16, 19, 22, 27, 35, 36, 39, 44, 46, 48, 51, 53, 55		26, 28, 31, 32.	2, 10, 11, 18, 29.
10	7, 8, 16, 19, 27, 35, 36, 44, 51, 55.			12, 24, 26, 29, 38.
11	7, 8, 16, 19, 35, 36, 44, 51, 55.			9.
12				24.
13				29.
14				29.
15	7, 8, 16, 19, 35, 36, 39, 43, 44, 51, 55		31.	5, 33, 37
16	7, 8, 44.			6, 12, 14, 15, 18, 23, 25, 29, 30, 38.
17	7, 8, 39, 43-45.		31.	14, 15, 29, 37.
18	7, 8, 39, 44.		30, 33.	5, 6, 12, 15, 29.
19	7, 8, 39, 44.		29, 31.	14, 15, 23, 33.
20	7, 8, 27.		32.	14, 15, 38, 44.
21	7, 8, 39, 45.		31.	32, 37.
22	7, 8, 27.		31.	32, 38.
23	7, 8, 44.			26, 29, 32.
24	7, 8, 45.		31, 32.	
25	7, 8.			32, 33
26	7, 8, 39, 44.			29.
27			31.	5, 6, 29, 33
28	7, 8, 39, 44.		31.	
29	7, 8, 44.		31.	37.
30			30, 31.	6, 33.
31	7, 8, 44.		31.	
32			31	5, 6.
33				12, 33
34			31.	5, 33.
35				5, 9.
36				38.

For sectors and pollutants specification, see appendices 3.1 and 3.2

abatement among the highly polluting sectors. The percentage of unabated pollution remains high for moderately polluting industries such as, machine tools and engineering (sector 40 to 44), transport equipment (46 to 49), watches and clocks (50), miscellaneous manufacturing (51) etc. These sectors abate around 0 to 40 percent of the actual pollution. There are certain sectors such as metallic and non-metallic minerals (7,8), wood and wooden products (19), engineering industries (40 to 50) that do not seem to abate at all. However, in this category the generation of pollution falls within the permissible standard limits. Thus, for such industries lower abatement level is not a serious concern. Now, we will look into the level of abatement in the case of all the sectors of the input-output table and for all the pollutants.

On the basis of the level of abatement performed in industries taken individually the various sectors have been classified into four broad categories in terms of the range of pollution, viz. 0 to 10, 10 to 30, 30 to 80 and above 80. The top row of the table 4.3 mentions the pollution abatement ranges. All the 36 pollutants are marked from 1 to 36 in different rows of the table. A sector number appearing in a particular range of pollution abatement gives the status of pollution abatement of that sector.

It is important to note that even after abatement no reduction in effluent quantity has taken place. This is due to the fact that recycling of water has still not become a common practice in India. Very few units have installed effluent treatment plants for full treatment of the effluents, so that the water can be recycled. In this way, the quantity of effluent remains same even after the abatement. It is only the concentration of effluents that changes after the treatment of wastewater. This becomes evident with the examination of sectoral pattern of abatement for different pollutants considered in this section.

A close examination of the table reveals that most of the highly polluting sectors have been abating more than 80 percent of the pollution. In the case of suspended and dissolved solids (2,6), we find that sectors such as dairy product (2), other livestock product (3), food products (9-12), textile (14,15, 18), paper (20), plastic (25), fertilizer

(29), pesticides (30), drugs (32), non-metallic mineral products (37) and iron steel (38), have all abated more than 80 percent of the generated pollution. The level of suspended solids in the case of leather (23), rubber products (24), heavy chemicals (28), has been generally higher in comparison to other highly polluting sectors. In the case of dissolved and fixed solids (3-5), highly polluting sectors have abated considerably at a high level.

Similar trend has been observed in the case of biological and chemical oxygen demand (7-8). For these pollutants, leather (23), rubber products (24), petroleum product (26), heavy chemicals (28) have highest abatement level , that is above 80 percent. In the case of chemical oxygen demand (8), some of the sectors such as textiles (14,15), paper products (20), paint varnishes (31) and other non-metallic products (27) have a bit lower level of abatement. Still, these sectors have shown at least 35-70 percent in the abatement status. Other remaining sectors have generally shown lower abatement level.

In the case of oil and greases (10) the level of abatement generally seems to be satisfactory. Pollutants of nitrogen are particularly discharged by rubber (24), fertilizer (29), petroleum (26), beverages (12) and sugar (9). All these sectors have satisfactory levels of abatement. Other sectors are having lower abatement level for the pollutants of nitrogen. Substantial quantities of zinc (17) and sulphate (18) are discharged by the fertilizer (29) industry. The sectors such as textile (14,15), drugs (32), non-metallic mineral product (37) and iron steel (38) are responsible for the discharge of phenolic compounds (20), lead (21) and cyanides (22) which has high abatement level that is, more than 80 percent. Paint varnishes (31) sector has discharged many toxic pollutants such as mercury (24), cadmium (29) and nickel (31). The level of abatement has not been very high for these pollutants. Drugs and medicine (32) is also one of the sector which has been responsible for discharge of many toxic pollutants.

Thus, we see that a high degree of abatement is seen among the highly polluting industries. Only in few instances of non-abatement sectors do we come across a direct

link of highly polluting industries. The results presented in this section have mainly highlighted the level of abatement in terms of percentage which seems to be satisfactory, yet in absolute terms it may still be high. In the later part of this chapter the issues related with absolute level of pollution will be discussed. The following section discusses the relative share of industries in direct pollution coefficients.

4.1.2 Relative Share of Industries in Direct Pollution Coefficients

On the basis of the pollution potential industries are classified as polluting or non-polluting. In this section, we attempt to explain the relative share of industries in total direct pollution. The relative ranking is based on the relative share in total direct pollution for 36 different pollutants considered in the present study. The after abatement values have been considered to determine the relative share of the industries as it is the actual pollution that enters into the environment. The relative share of each industry is expressed in terms of percentage with respect to the total of direct pollution intensity. Table 4.4 explains the summary of the relative share of different industries in direct pollution intensity.

Like in the previous section, here too, on the basis of relative share the entire direct pollution effects have been divided into certain ranges viz. 0 to 2, 2 to 5, 5 to 10 and above 10 percent. The share and ranking of industries would be different in the case of different pollutants and industries.

Sectors that show a major share in effluent quantity are marked with more than 10 percent share in direct pollution intensity. The highest share in the case of effluent quantity (1) has been from coal and lignite (5), paper (20) and drugs (32), followed by fertilizer (29), synthetic fibers (34) and electricity (53). Dairy (2), crude petroleum (6), synthetic fiber (17), heavy chemicals (28) also discharge substantial quantities of effluents.

Table 4.4: **Summary- Relative Share of Sectors in Direct Pollution Intensity**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-2%	2-5%	5-10%	above 10%
1	3, 7-15, 18, 19, 22-27, 30, 31, 33, 35-40, 43, 45, 48, 49, 51.	2, 6, 17, 28, 50.	29, 34, 53.	5, 20, 32.
2	3, 7-11, 14-15, 19, 24, 25, 27, 30, 31, 35-43, 45, 48-51.	2, 20, 23, 29.	32.	12, 28, 53.
3	9, 10, 13-15, 25, 31, 33, 38, 40, 41, 47, 48.	17, 49, 53.	12, 23, 34.	3, 24, 28, 29.
4	14, 15, 17, 23, 26, 31, 33, 34.			6.
5				14, 15, 25.
6				17, 31, 34.
7	3, 7-11, 13-15, 18, 19, 22-24, 26, 27, 30, 31, 35-38, 40, 48, 49, 51, 55.	2, 29, 50.	17, 20, 28.	12, 32, 34.
8	3, 7-11, 13-15, 18, 19, 22-24, 26, 29-31, 35-38, 40, 48, 49, 51, 55.	50, 53.	2, 17, 28.	20, 32, 34.
9	7-11, 13-15, 18, 19, 22, 26-28, 35, 36, 48, 51, 55.	2.	29, 31.	32, 53.
10	7, 8, 16, 19, 24, 35, 36, 51, 55.	26, 27.	12, 38.	29.
11	9, 16, 19, 55.	35, 51.		7, 8, 36.
12				24.
13				29.
14				29.
15	7, 8, 36, 39.		5.	31.
16	7, 8, 12, 14, 15, 23, 25, 29, 30.			6.
17	7, 8, 14, 15, 19, 29, 37, 39, 45.			31.
18	7, 12, 19, 30, 33.		39.	5, 6, 8, 29.
19	7, 8, 14, 15, 19, 33.			23, 29, 31.
20	7, 14, 15, 19.		8.	27, 32, 38.
21	7, 8, 32, 37, 39, 45.			31.
22	7, 8, 19.	27.		31, 32, 38.
23	19, 26.	7.		8, 29, 32.
24	8, 32.			31.
25	19, 33.	7.		8, 32.
26	7, 8.			29.
27	29, 31.		5.	6.
28	7, 19, 39.			8, 31.
29	19.	7.		8, 31, 37.
30	30, 31.			6.
31		7.		8, 19, 31.
32	31.			5, 6.
33				12
34			5.	31.
35	9.			5.
36				30.

For sectors and pollutants specification, see appendices 3.1 and 3.2

For pollutants like insoluble solids (2-6) the major polluting sectors are beverages (12), heavy chemicals (28), electricity (53), crude petroleum (6), textile (14,15,17), plastic product (25), paint and varnishes (31) and synthetic fiber (34). All these sectors have more than 10 percent share of the total. Other sectors that need attention in this regard are drugs (32), dairy (2), paper (20), leather (23) and fertilizer (29).

In the case of biological and chemical oxygen demand (7,8) the major share come from beverages (12), paper (20), drugs (32) and synthetic fibers (34). These sectors have more than 10 percent share of the total. Other sectors that have 5 to 10 percent share are dairy (2), synthetic textile (17) and heavy chemicals (28). Fertilizer (29) and electricity (53) are also responsible for a substantial share in total.

Oil and greases (9) are responsible for much of the pollution in watercourses. The sectors that have a share of more than 10 percent include drugs (32) and electricity (53). They are followed by fertilizer (29), paint varnishes (31) and dairy products (2). The remaining sectors either do not discharge any quantity of oil and greases or they have share of 0 to 2 percent.

We have already mentioned that pollutants of nitrogen compound (10-14) are mainly produced by the fertilizer industry. Hence the major share of this is held by this sector. Apart from this, other important sectors that have a potential of nitrogenous waste are beverages (12), rubber (24), petroleum products and coal tar products (26,27).

Pollutants such as iron (15), zinc (17), lead (21), mercury (24) and aluminium (34) are solely discharged by the paint and varnishes (31) industry. As the table 4.4 shows, in the case of remaining pollutants the major share is held by one or two sectors. These pollutants are generally not discharged on large scale by all the sectors of the input-output table. Rather, they are specifically discharged by a few producing sectors. Thus, almost entire share is concentrated with the sector that have a potentials for a particular pollutant. Some of the toxic pollutants such as phenolic compounds (20) and cyanides (22) are discharged by coal tar products (27), drugs (32), paints (31)

and iron steel (38). The major share in phosphates (23) is that of drugs (32) and fertilizer (29). Almost the entire quantity of the fluorides (26) is discharged solely by the fertilizer (29) industry. Dissolved phosphates (36) is discharged by the pesticides (30). For other pollutants, paint varnishes (31), drugs (32), crude petroleum (6) are the major contributors.

Thus, we find that dairy, beverages, textiles, paper, leather, plastics, fertilizer, paint varnishes, drugs, chemicals are the common sectors present in most of the pollutants with major share. All these sectors are among the highly polluting sectors. Thus, it is important to consider the share of highly polluting sectors in the total pollution generation. The following section will look into the share of highly polluting sectors in direct pollution intensity.

4.1.3 Share of Highly Polluting Industries

In the previous section we saw that the major share of almost all the pollutants discharged comes from the highly polluting sectors. It is also clear from table 4.1 in which high direct pollution intensity is seen in the case of almost all highly polluting sectors. If we calculate the overall percentage of the quantity discharged by the highly polluting sectors, we find that in some cases highly polluting sectors are responsible for 100 percent share whereas in others it is even zero. Thus, there is a large variation depending upon the nature of the pollutants. The highly polluting sectors are responsible for upto 80 percent share for the major pollutants such as effluent quantity, insoluble solids, biological oxygen demand, chemical oxygen demand and oil and greases. The overall direct generation of effluent quantity (1) has been around 64 percent in the case of highly polluting industries. Highly polluting sectors have shown more than 90 percent share for the pollutants such as dissolved phosphate (36), potassium (33), nitrate nitrogen (14), organic nitrogen (13), total nitrogen (12), total volatile solids (6), dissolved fixed solids (5), mercury (26), fluoride (26), lead (21), zinc (17), oil and greases (9), total suspended solids (2), chromium (19), biological oxygen demand (7),

iron (15), aluminium (34), total dissolved solids (3) and chemical oxygen demand (8).

The share of highly polluting sectors varies between 50 to 90 percent for the pollutants such as copper (28), cyanide (22), ammonical nitrogen (10), phenolic compound (20), nickel (31), phosphate (23), hexavalent chromium (25), cadmium (29) and sulfate (18). The remaining pollutants have a share of below 4 percent.

Now we will look into the disaggregated patterns of discharge. The summary results are shown in table 4.5. Like in the earlier analysis, here too, for the purpose of comparison the entire result has been classified into certain ranges, viz. 0 to 2, 2 to 5, 5 to 10 and above 10 percent. The top most row indicates these ranges. After that, 36 pollutants are marked from 1 to 36 in different rows. A particular sector corresponding to a row and column explains its position in terms of its share in the case of a particular pollutant. A close examination of the table reveals that dairy (2), beverages (12), textiles (14,15,17), paper (20), leather (23), rubber (24), heavy chemicals (28), fertilizers (29), paint varnishes (31), drugs and medicine (32) and synthetic fiber (34) are the common sectors and appear in the case of most of the pollutants with more than 10 percent share. Thus, these sectors need special attention because of their high pollution potential and large share. In the earlier case also, we saw that these sectors have been responsible for a significant amount of pollution generation. In the next section, we will consider the total effects (direct plus indirect).

4.2 Direct-Indirect Water Pollution Intensity

The results discussed in the previous section are similar to the results that could be attained by any of the conventional methods or analyzes. However, the uniqueness of the input-output technique is not in analyzing the direct effects but to trace the interaction effect through consecutive iterations that are generated among the sectors of the input-output table. The elements of the $(I - A)^{-1}$ give an entirely different insight for the analysis of such interactions by capturing direct and indirect flows of

Table 4.5: **Summary- Share of Highly Polluting Industries in Direct Pollution Coefficients**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-2%	2-5%	5-10%	above 10%
1	3, 14, 15, 1.	12, 24, 28.	2, 5, 29, 7.	20, 32, 34.
2	10, 14, 31.	2, 20, 23, 24, 29.	32.	12, 28, 50.
3	14, 15, 33, 38.	10, 17, 53.	12, 23, 34.	2, 24, 28, 29.
4		15, 33.	14, 26, 31.	17, 23, 34.
5			25.	14, 15.
6				17, 31, 34.
7	3, 14, 23, 24.	2, 31.	17, 20, 29.	12, 28, 32, 34.
8	14, 15, 17, 23	24, 29, 31, 53.	2, 28.	20, 33, 34.
9	14, 15, 31.	2.	29.	32, 53
10		26.	7, 38.	29.
11				9, 16.
12				24.
13				29.
14				29.
15				31.
16	25.	15.	14.	12, 23, 29.
17				31.
18				12, 29, 39.
19	14, 15.			23, 29, 31.
20				32, 38.
21				31
22				31, 32, 38.
23				29, 32.
24		32.		31.
25	33.			32.
26				29.
27				29, 31.
28				31.
29				31.
30	33.		31.	30.
31				31.
32				31.
33				12.
34				31.
35				9.
36				30.

For sectors and pollutants specification, see appendices 3.1 and 3.2

the residual generation. We have already mentioned in the methodological part of chapter 2, how the direct and indirect effects of residual generation can be captured under the input-output framework. Equation (2.41) was used to explain the direct and indirect effects of pollution generation as a result of the different pattern of final demand. Thus, the direct and indirect effects are calculated with effect from change in the final demand worth of rupees one lakh by the following relationship—

$$A_{21}(I - A_{11})^{-1} \tag{4.1}$$

Equation (4.1) calculates the total (direct plus indirect) water pollution coefficients. The detailed results of these coefficients for the year 1993-94 are given in appendix 4.1. The quantity of pollution generation is expressed in terms of tons per lakh rupees of output. If we look into the results, given in appendix 4.1, we find that the pollution intensity at a disaggregated level is distinctively different in all the sectors of the input-output table. The summary results of the direct and indirect water pollution coefficients (given in appendix 4.1) are presented in table 4.6. In order to make these results convenient for comparison, we have classified the total (direct plus indirect) effects into some appropriate ranges, viz. 0 to 0.01, 0.01 to 0.05, 0.05 to 0.10 and above 0.10 intensity (in thousand cu.m/tons per lakh rupees of output).

It can be seen from the table 4.6 that in the case of effluent quantity, almost all the sectors are in the high intensity range except for a few non-polluting sectors. This is because of the indirect effect that has increased the magnitude of the pollution intensity. We saw that in the case of direct water pollution intensity, except for the non-polluting sectors, all the sectors are responsible for the discharge of some effluent quantity. The interaction effect among the producing sectors is responsible for the increase in pollution intensity. Now, even some of the non-polluting sectors have also started discharging high pollution intensity. Sectors such as drugs and medicine (32), coal and lignite (5), paper and paper based product (20), synthetic fiber, resin (34), coal tar product (27) and electricity (53), show very high pollution intensity, that is, above 0.90. Forestry, logging and fishing (4) is the only sector that has low pollution

Table 4.6: **Summary– Direct Plus Indirect Water Pollution Intensity**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-0.01	0.01-0.05	0.05-0.10	above 0.10
1		4.	1, 3, 19, 54, 56.	2, 5-18, 20-53, 55.
2	3, 4, 6.	8, 9, 11, 13, 16, 19, 26, 52, 56.	1, 2, 5, 7, 10, 14, 15, 17, 18, 21-25, 27, 34, 35, 37, 38, 40-51, 54, 55.	12, 20, 28-33, 36, 39, 53.
3	3, 4, 6-8, 19, 26, 27, 54.	1, 5, 9, 13, 15, 16, 18, 20, 21, 35-44, 46-48, 51, 52, 55	10, 11, 14, 22, 25, 32.	2, 12, 17, 23, 24, 28-31, 34, 53.
4			2, 3, 56.	1, 4-55.
5	1-13, 16-56.	14, 15.		
6	1-16, 18-24, 26-30, 32, 33, 35-56.	17, 25, 31.	34.	
7	3-11, 13-16, 18-19, 22, 26, 27, 35-49, 51-56.	2, 20, 21, 23-25, 29-31, 33, 50.	17, 28, 34.	12, 32.
8	1, 4, 6, 26, 54.	3, 5, 7-16, 18, 19, 22, 23, 27, 35-49, 51, 52, 55, 56.	2, 24, 25, 29-31, 33, 50, 53.	17, 20, 21, 28, 32,
9	1-31, 33-52, 54-56.	53.	32.	
10	1-28, 30-56.	29.		
11	all			
12	all			
13	all			
14	all			
15	1-4, 6-30, 32-45, 47-56.	5, 46.		31.
16		2, 3, 56.	4, 13, 19, 54.	1, 5-12, 14-18, 20-53, 55.
17	1-30, 32-56.		31.	
18	1-4, 9, 11, 13, 16, 19, 22, 54, 56.	7, 10, 12, 14, 15, 17, 18, 20, 21, 24-26, 28, 30-35, 37, 38, 40-52, 55.	6, 8, 36, 39, 53.	5, 27, 29.
19	all			
20	all			
21	all			
22	all			
23	all			
24	all			
25	all			
26	1-28, 30-56			29.
27	2-4, 8, 13, 19, 54, 56.	1, 7, 9-12, 14-18, 20-25, 28, 30-52, 55	5, 53.	6, 26, 27, 29.
28	all			
29	all			
30		2-4, 8, 13, 19, 54, 56	1, 5, 9-12, 14-18, 20-23, 40-44, 46-52.	6, 7, 24-39, 45, 53, 55.
31	all			
32	1-4, 7-25, 30, 32, 33, 35, 39-52, 54, 56.	5, 27-29, 31, 34, 36-38, 53, 55.		6, 26.
33	1-11, 13-56.	12.		
34	1-30, 32-45, 47-56.	46.		31.
35	1-4, 6-19, 21-26, 29-34, 41-52, 54-56.	20, 28, 35-40, 53.	27.	5.
36	all			

Ranges indicate quantity of pollutants per lakh rupees of output. For sectors and pollutants specification, see appendices 3.1 and 3.2

intensity in the case of effluent quantity.

Insoluble suspended matters such as total suspended solids (2), total dissolved solids (3), total solids (4), dissolved fixed solids (5), total volatile solids (6), have important environmental consequences and therefore are a cause of concern. Sectors that have high intensity for most of the insoluble solids include, beverages (12), paper (20), chemical and chemical products (28-33), leather (23), synthetic fiber (34), electricity (53). Apart from this dairy (2), sugar, edible oil and food products (9-11), textiles (14,15,17,18), rubber (24), plastics (25), coal tar products (27), non-metallic mineral products (37), iron-steel (38), batteries (45) have also appeared with high intensity. The most important parameter of suspended solids i.e. total solids (4) is found with high intensity in almost all the sectors. In the case of dissolved fixed solids (5) and also total volatile solids (6) most of the industries have appeared with low intensity.

Many highly polluting sectors have shown high intensity in the case of biological and chemical oxygen demand (7,8). These pollution parameters are important for the assessment of the water quality. The industrial water effluent contains high amount of chemical and biological matter and thereby imposes a high demand on the oxygen present in water. As a result of heavy biological oxygen demand (BOD) and chemical oxygen demand (COD), a heavy demand on oxygen is placed on water due to the discharge of effluents into our watercourses. Thus, the pollution intensity for BOD and COD are important determinants for the characteristics of effluents. In the case of biological oxygen demand (7), sectors such as beverages (12), drugs (32), synthetic textile (17), heavy chemicals (28), synthetic fibers (34) fall under the high intensity sectors. Apart from the above sectors, in the case of chemical oxygen demand (COD) some more sectors such as dairy (2), rubber (24), plastics (25), fertilizer (29), pesticides (30), paint varnishes (31), other chemicals (33) have appeared with high intensity.

Majority of the sectors have lower intensity for oil and greases (9) and nitrogenous pollutants (10-14). This is because these pollutants are not discharged on a large scale and also because they are specific to few sectors. Thus, the interaction effect is not very

significant. However, even small quantities of pollutants like oil and greases have very serious implications for the water quality of our resources. It has a tendency to spread over a surface of water and the diffusion of oxygen into water is inhibited and the re-airation of water is affected. The absorption of oxygen from air into water depends on the thickness of the film formed by oil. Even a small quantity of oil spreads over the surface and causes serious damage to the water habitats. Sectors such as drugs and medicine (32), electricity (53) appear with the intensity in the second lowest range of 0.01 to 0.05. All other remaining sectors have been found in the lowest range of 0 to 0.01.

Nitrogenous pollutants such as ammonical nitrogen (10), total kjedahl nitrogen (11). total nitrogen (12), organic nitrogen (13), nitrate nitrogen (14) are specific to a few sectors like fertilizer (29) and rubber (24). Thus, the intensity has been generally in the lower range for most of the sectors. The indirect effect on agriculture sector (1) is important in this case.

Some of the sectors such as battery, paint varnishes, engineering, electro plating, basic metals, rubber processing etc, contain considerable amount of heavy metals in the discharge of effluents. The metallic solution is toxic and inhibits the process of self-purification of river. As far as metallic products are concerned, they have shown almost the same pattern in terms of intensities. In the case of iron (15), paint varnishes (31) has the highest intensity- more than 0.2. We find that paint and varnishes (31) has been responsible for the discharge of many toxic pollutants.

In the case of chlorides (16) almost all the highly polluting sectors have appeared with high intensity. Sectors such as fertilizer (29), coal tar (27), cement (36), non-ferrous basic metal (39) and electricity (53) are responsible for the discharge of sulphate (18) with high to moderate pollution intensity. All the sectors have lower intensity for the pollutants such as zinc (17), chromium (19), phenolic compounds (20), lead (21), cyanides (22), phosphate (23), mercury (24), hexavalent chromium (25), copper (28), cadmium (29), nickel (31), dissolved phosphate (36). This is primarily because these

pollutants are specific to a limited number of sectors and thus their inter-relatedness with other sectors does not appear to be very significant. For the remaining pollutants, the intensity has generally been low for majority of the sectors.

Thus, we find that most of the highly polluting industries dominate in the case of total (direct plus indirect effects) intensity as well.. However, some non-polluting sectors have also emerged with high pollution intensity. The differences that exist in the case of 'direct' and 'direct plus indirect' pollution intensity will be discussed in the next section. In order to have exact idea about the pollution potential of different sectors, we have discussed the relative share of industries in total pollution intensity in the following section.

4.2.1 Relative Share of Industries in Total (Direct Plus Indirect) Pollution Intensity

In the previous section we saw the pattern of the direct plus indirect water pollution intensity for all the sectors of the input-output table. We found that like in the case of direct pollution intensity here also the highly polluting sectors have occupied major position. But the major difference is seen in terms of the magnitude of intensity. The high intensity as a result of indirect effect is very much prominent especially in the case of effluent quantity (1). Though previous analysis gives a complete picture of total intensity, a comparative or relative picture is still found to be missing. This would become clear only when we look into the relative share in terms of percentage. Table 4.7 gives the summary results of relative share for all industries of 36 different pollutants.

The relative share of industries in total (direct plus indirect) pollution intensity may be different from that of direct pollution intensity. Again the ranking of industries would be based on after abatement pollution intensity. Like in the case of direct pollution intensity, here too, for the sake of comparison, the entire effects have been

Table 4.7: **Summary– Relative Share of Sectors in Total (Direct Plus Indirect) Pollution Intensity**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-2%	2-5 %	5-10 %	above 10 %
1	1-4, 6-16, 18-19. 22-26, 30, 31, 33, 35, 37, 39-49, 51, 52, 54-56.	17, 21, 27-29, 34, 36, 38, 50, 53.	20.	5, 32.
2	1-11, 13-19, 21-27, 34, 35, 37, 38, 40-52, 54-56	12, 20, 29-33, 36, 39	28	53
3	1, 3-11, 13-16, 18-22, 26, 27, 32 35-48, 50-52, 54-56	12, 17, 23, 25, 30, 31, 33, 49, 53,	2, 24, 29, 34.	28
4	1-5, 7-25, 28, 30-33, 35-52, 54, 56	29, 34, 53, 55	27	6, 26
5	1-13, 18-24, 26-56.	16, 17, 25.		14, 15.
6	1-16, 18-23, 26-30, 32,33, 35-56.		24, 31.	17, 25, 34.
7	1-11, 13-16, 18,19, 21-23, 26, 27, 30, 33, 35-49, 51-56.	20, 24, 25, 29, 31, 50.	17, 28, 34.	12, 32.
8	1, 3-16, 18-19, 22, 23, 26, 27, 33, 35-49, 51, 52, 54-56.	2, 17, 21, 24, 25, 29-31, 50, 53.	28, 34.	20, 32.
9	1-28, 30-31, 33-52, 54-56.		29, 53.	32.
10	2-7, 9-11, 13-26. 28, 30-35, 37, 39-56.	1, 12, 27, 36, 38.	8.	29.
11	1-6, 9-28, 30-34, 38-50, 53-56.	29, 51-52.	7, 35, 37.	8, 36.
12	1-21, 23, 25-40, 42-47, 50-54, 56.	22, 41, 48, 49, 55.		24.
13	2-8, 11-28, 31-56.	9, 10, 30.		29.
14	2-8, 11-28, 31-56.	9, 10, 30.		29.
15	1-4, 6-20, 22, 24-30, 32-45, 47-56	5, 21, 23.	46.	31.
16	1-5, 7-25, 28, 30-52, 54, 56.	29, 53, 55.	27.	6, 26.
17	1-20, 22, 24-30. 32-45, 47-56.	21, 23.	46.	31.
18	1-4, 7, 9-19, 21-25, 28,30-34, 37, 40-52, 54-56.	6, 8, 20, 26, 35, 36, 38, 39, 53.	27, 29.	5.
19	1-22, 24-28, 30, 32-45, 47-56.	46.		23, 29, 31.
20	1-31, 33-37, 45,51, 53-56.	39-44, 46-50, 52.		32, 38.
21	1-22, 24-30, 32-45, 47-56.	23.	46.	31.
22	1-7, 9-26, 28-30. 33-37, 39, 44, 45, 49-51, 53-56.	27, 40-43, 46-48, 52.	8, 32.	31, 38.
23	1-7, 9-28, 30, 31, 33-34, 36-56.	35.		8, 29, 32.
24	1-20, 22, 24-30, 32-45, 47-56.	21, 23.	46.	31.
25	1-6, 9-31, 33, 34, 38-56.	7, 35-37.		8, 32.
26	2-8, 11-28, 31-56.	1, 9, 10, 30.		29.
27	1-4, 7-25, 28, 30-52, 54-56.	5, 29, 53, 55.	27.	6, 26.
28	1-7, 9-30, 32-45, 47-56.		8, 46.	31.
29	1-6, 9-30, 32-45, 47-56.	7, 46.		8, 31
30	1-5, 7-25, 28, 30-52, 54, 56.	29, 53, 55.	27.	6, 26.
31	1-7, 9-30, 32-45, 47-56.	46.		8, 31.
32	1-4, 7-25, 28, 30-52, 54-56.	5, 29, 53.	27.	6, 26.
33	1-11, 13-56.			12.
34	1-20, 22, 24-30, 32-45, 47-56.	21, 23.	46.	31.
35	1-4, 6-19, 21-26, 29-34, 37, 39-52, 54-56.	20, 28, 35, 36, 38.	27, 53.	5.
36	1-29, 31-56.			30.

For sectors and pollutants specification, see appendices 3.1 and 3.2

classified into four categories viz. 0 to 2 percent, 2 to 5 percent, 5 to 10 percent and above 10 percent. Now we will examine the relative share of each industry for each pollutant.

In the case of effluent quantity (1), coal and lignite (5) and drugs and medicine (32) contribute for more than 10 percent share. Paper and pulp (20) has also contributed significantly. The remaining sectors have a share of less than 5 percent. In the case of insoluble solids (2-6), the important sectors with more than above 10 percent share are electricity (53), heavy chemicals (28), crude petroleum and petroleum products (6,26), textiles (14,15, 17), plastics (25) and synthetic fibers (34). In the case of direct pollution coefficients, some of the sectors such as beverages (29), fertilizer (29), paint and varnishes (31) etc have a major share. Now in the case of total (direct plus indirect) intensity, they are having below 5 percent share. This is because the share of some of the moderately and low polluting sectors have increased significantly.

Sectors such as beverages (12), drugs (32) and paper (20) have more than 10 percent share for biological and chemical oxygen demand (7,8). Drugs and medicine (32) has a major share in the case of oil and greases (9). Fertilizer (29) and rubber products (24) are the prime sources for nitrogenous pollutants (10-14). Paint varnishes (31), fertilizer (29), leather (23) sectors are found to be contributors of pollutants of metallic compounds.

Thus, in this analysis we have found that although similarities have been observed in the pattern of major polluting sectors of 'direct' and 'direct plus indirect' pollution intensity, there are some significant differences to be marked as well. The most important difference is that some of the non-polluting sectors have occupied major role in many cases. Because of the indirect effect generation, non-polluting, low or moderately polluting sectors have also become significant contributors. This has lessened the relative share of highly polluting sectors. Thus, the relative share of highly polluting sectors has fallen down to some extent. We can clearly observe that some sectors with a major share in the case of direct pollution are now show relatively smaller share in the case

of direct plus indirect intensity. This implies that indirect effects generated because of the inter-relationships among the producing sectors are important and should be considered in the analysis. Now, in the next section we examine the inter-relationship effects among the highly polluting sectors.

4.2.2 Direct-Indirect Pollution Generation by Highly Polluting Industries

The foregoing analysis has shown that highly polluting sectors are a major cause of pollution. We saw that the direct pollution generated by the moderately or low polluting sectors was only a small proportion of the total direct pollution intensity. The pollution intensity from low and moderately polluting sectors was increased only in the total pollution intensity analysis. Direct plus indirect pollution intensity considered in the preceding sections examined the interaction effect of all the sectors of the input-output table. The earlier analysis was not capable of explaining the exclusive effects generated out of inter-relationships of the highly polluting sectors. Thus, it is important to consider the effects (direct plus indirect) generated by the highly polluting sectors. In this section we have derived the direct and indirect effects generated by the inter-relationships between the highly polluting sectors. This has been done by taking the pollution coefficients of highly polluting sectors only and assuming the pollution from other sectors to be zero. The resulting output is the total effect (direct plus indirect) generated out of the interaction of highly polluting sectors alone. Appendix 4.2 shows the detailed results of direct and indirect effects generated by the highly polluting sectors for the year 1993-94. The same results are shown in summary form in table 4.7.

The aim of this analysis is to find out the interaction effect generated by the highly polluting sectors. The results given in appendices show that there is very little difference found between the interaction effect of all the sectors (appendix 4.1) and interaction effect of the highly polluting sectors (appendix 4.2). In order to compare

Table 4.8: **Summary– Total (Direct Plus Indirect) Pollution Intensity of Highly Polluting Sectors**

(Sector codes are given in rows and columns)

Ranges→ Pollutants↓	0-0.01	0.01-0.05	0.05-0.10	above 0.10
1		4, 6, 8, 19, 26, 54.	1, 3, 5, 7, 9, 10, 16, 18, 22, 35, 46, 47, 52, 55, 56.	2, 11-15, 17, 20, 21, 23-25, 27-34, 36-45, 48-51, 53
2		3, 4, 6, 8, 9, 11, 13, 16, 19, 26, 35, 52, 56	1, 2, 5, 7, 10, 14, 15, 17, 18, 21-25, 27, 34, 37, 38, 40-51, 54-55.	12, 20, 28-33, 36, 39, 53.
3	4, 6, 8, 26, 35, 54, 56.	1, 3, 5, 7, 9, 13, 15, 16, 18-21, 27, 36-44, 46-52, 55.	10, 11, 14, 22, 25, 32, 33, 45	2, 12, 17, 23, 24, 28-31, 34, 53.
4	1-13, 16, 18-21, 27-30, 32, 35-44, 46-56	14, 15, 22, 24, 26, 31, 33, 45	25.	17, 23, 34.
5	1-13, 16-56.	14, 15.		
6	1-24, 26-30, 32, 33, 35-56.	25, 31.	34.	
7	1, 3-11, 13-16, 18, 19, 22, 26, 27, 35-56	2, 20, 21, 23-25, 29-31, 33.	17, 28, 34.	12, 32.
8	1, 4, 6-8, 26, 54.	3, 5, 9-16, 18, 19, 22, 23, 27, 35-52, 55, 56.	2, 24, 25, 29-31, 33, 53.	17, 20, 21, 28, 32, 34.
9	1-31, 33-52, 54-56.	53.	32.	
10	1-28, 30-56.	29.		
11	all			
12	all			
13	all			
14	all			
15	1-30, 32-45, 47-56.	46.		31.
16	1-11, 13-22, 24-56	12, 23.		
17	1-30, 32-56.	31.		
18	1-11, 13-28, 30-38, 40-44, 46-56.	12, 45.	29, 39.	
19	all			
20	all			
21	all			
22	all			
23	all			
24	all			
25	all			
26	1-28, 30-56			29
27	all			
28	all			
29	all			
30	all			
31	all			
32	all			
33	1-11, 13-30, 32-56.	12.		
34	1-30, 32-45, 47-56.	46.		31.
35	all			
36	all			

Ranges indicate quantity of pollutants per lakh rupees of output. For sectors and pollutants specification, see appendices 3.1 and 3.2

the two cases, we classify the pollution intensity into four appropriate ranges, viz. 0-0.01, 0.01-0.05, 0.05-0.10 and above 0.10 (in tons per lakh rupees of output).

It is clear from the table 4.7 and appendix 4.2 that the exclusion of non-polluting and moderately polluting sectors does not make much difference on the generation of pollution intensity of different sectors. Most of the sectors still occupy the same position as they did in the earlier case. In the case of effluent quantity (1) some of the highly polluting sectors such as sugar (9), edible oil (10) and some non-polluting sectors have appeared in the intensity range of 0.05 to 0.10 instead of the above 0.10 range. Yet most of the highly polluting sectors hold still their position in the highest intensity range. Similarly, in the case of suspended insoluble matters exactly the same match is found. The only difference appears in the case of non-polluting sectors. Now some of the non-polluting sectors have shifted to the lowest intensity range. This is because of the elimination of the direct pollution effect from these sectors. In this case, the pollution intensity of low or moderately polluting sectors indicate only the indirect component. No significant difference is seen otherwise.

In the case of total solids (4), many polluting as well as non-polluting sectors have moved downwards, that is, to lower intensity ranges. At the same time, some of the highly polluting sectors such as synthetic textile (17), leather (23) and synthetic fiber (34) have remained in the higher intensity range. All the sectors appear to be at the same position for pollutants such as biological and chemical oxygen demand (7,8), oil and greases (9), nitrogenous pollutants (10-14), iron (15), chlorides (16), zinc (17) and sulphate (18).

The major difference is seen only for calcium (27) and sodium (30). Many polluting sectors such as crude petroleum (6), petroleum products (26), coal tar products (27), fertilizers (29), rubber (24), plastics (25), chemical and chemical related products (28-34) have disappeared from the high intensity range. This is because these pollutants are not discharged by the highly polluting sectors. Rather, they are associated with the low or moderately polluting sectors. In the case of magnesium (32) all the

sectors are found to be concentrated in the lowest range. Earlier they were distributed between two lower ranges instead of one. This change is not very significant. The same is applicable for pollutants like aluminium (34) and total acids (35) as well.

The analysis implies that most of the pollution in the environment is generated by the highly polluting sectors. In the case of many pollutants, highly polluting sectors have generated almost the entire quantity. The contribution of non-polluting sectors is not very significant. Although in some of the cases, the resulting pollution intensity has fallen because of the removal of some of the sectors, the change has never been very prominent. In the case of major pollutants such as effluent quantity (1), insoluble solids (2-6), biological oxygen demand, chemical oxygen demand (7,8) and oil greases (9), we have not observed any significant difference between the two cases. Thus, we can conclude that most of the pollution in the environment is generated by the highly polluting sectors.

4.3 Comparative Analysis of Direct and Direct Plus Indirect Pollution Intensity

We have already analyzed separately the 'direct' and 'direct plus indirect' pollution intensity for all the sectors of the input-output table. We have seen that substantial difference exist in these two cases. Table 4.8 presents the comparative analysis of the above two cases. From this table two observations can be made. First, in the case of direct pollution intensity, we find that not all pollutants are discharged by all the sectors. Thus, direct pollution coefficients matrix has many cells with zero value character. On the contrary, in the case of direct plus indirect pollution intensity all the sectors are responsible for some quantity or discharge of pollutants– thus, the zero pollution coefficients have disappeared. The coefficients are small in some cases but very significant in some others. This implies that indirect effects generated during the process of production are important and should be incorporated while discussing the

overall effects. Second, all sectors discharge higher quantities of all the pollutants in the case of direct plus indirect pollution intensity. In some cases this increase is very significant and in some it is not. This is also due to the indirect effects which are not equal in all the cases. This implies that the indirect effect is higher in some cases and lower in some other cases. Thus, while declaring a sector as highly polluting, polluting or non-polluting we should take into consideration these indirect effects which is not same for all the cases. A sector may be non-polluting with regard to direct pollution intensity, but it may generate more pollution indirectly because of its interdependence on polluting sectors. Keeping the above two factors in mind, here we attempt to discuss the differentials that arise between direct and direct plus indirect effects.

Table 4.8 shows that there has been significant increase in pollution intensity, due to the indirect effects generated among the sectors. We have already seen in the case of direct-indirect pollution intensity that how much direct and indirect pollution is generated in absolute terms by each sector. Now, we confine ourselves to a discussion of indirect pollution. In the case of effluent quantity (1) we find that the highest increase in terms of indirect pollution is observed for coal tar product (27), drugs (32), paper (20), electricity (53), cement (36), printing and publishing (21), plastic product (25), synthetic fiber (34) and iron and steel (38). Other polluting sectors have also been responsible for significant quantities of indirect pollution generation. Under the highly polluting category, the smallest increase has been observed in the case of dairy (2) sector. Overall, drugs (32), paper (20), fertilizer (29), synthetic fiber (34), miscellaneous manufacturing (50), synthetic textiles (17), electricity (53), heavy chemicals (28), cotton textiles (14), rubber products (24), woolen textiles (15), iron steel (38), food products (11), other non-metallic mineral products (37) and metallic minerals (7), show many fold increase due to indirect effects. It is important to note that the majority of these sectors falls under the category of highly polluting sectors. Thus, the largest threat to environment comes from this category that has high direct and high indirect effect. For other sectors also this increase has been very significant.

All engineering sectors (40-50), have generated indirect effect of more than 0.20.

Table 4.9: **Comparison of Direct and Direct Plus Indirect Pollution Intensity**

Poll.→	1		2		3		4		5		6	
Sec.↓	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I
1	0	0.098	0	0.031	0	0.037	0	0.208	0	2.E-05	0	1.E-04
2	0.314	0.351	0.04	0.051	0.345	0.357	0	0.077	0	1.E-04	0	9.E-05
3	0.042	0.081	0.004	0.015	0	0.011	0	0.075	0	3.E-05	0	7.E-05
4	0	0.023	0	0.006	0	0.003	0	0.137	0	2.E-04	0	1.E-04
5	2.287	2.426	0	0.070	0	0.016	0	0.300	0	5.E-05	0	2.E-04
6	0.376	0.410	0	0.013	0	0.004	10.282	10.449	0	2.E-05	0	8.E-05
7	0.012	0.116	0.001	0.061	0	0.014	0	0.385	0	3.E-05	0	2.E-04
8	0.081	0.124	0.008	0.028	0	0.007	0	0.172	0	2.E-05	0	1.E-04
9	0.016	0.117	5E-04	0.034	0.002	0.029	0	0.236	0	5.E-05	0	2.E-04
10	0.007	0.144	0.001	0.052	0.029	0.065	0	0.241	0	1.E-04	0	3.E-04
11	0.021	0.178	0.001	0.038	0	0.073	0	0.281	0	9.E-05	0	4.E-04
12	0.173	0.340	0.152	0.195	0.086	0.108	0	0.242	0	7.E-05	0	4.E-04
13	0.011	0.149	0.001	0.031	0.007	0.022	0	0.175	0	1.E-04	0	3.E-04
14	0.079	0.265	0.008	0.072	0.015	0.051	0.023	0.341	0.013	0.015	0	0.003
15	0.051	0.246	0.005	0.064	0.01	0.043	0.015	0.319	0.009	0.012	0	0.003
16	0	0.133	5E-06	0.041	0	0.023	0	0.236	0	0.001	0	0.002
17	0.299	0.653	0	0.085	0.072	0.148	0.078	0.483	0	0.001	0.025	0.039
18	0.009	0.178	1E-05	0.078	0	0.024	0	0.368	0	0.001	0	5.E-04
19	0.001	0.080	8E-05	0.026	0	0.011	0	0.168	0	1.E-04	0	0.001
20	1.001	1.599	0.035	0.148	0	0.049	0	0.362	0	2.E-04	0	0.001
21	0	0.468	0	0.071	0	0.025	0	0.259	0	2.E-04	0	0.001
22	0.006	0.131	0.001	0.053	0	0.051	0	0.240	0	4.E-04	0	0.001
23	0.026	0.154	0.037	0.095	0.09	0.157	0.109	0.363	0	2.E-04	0	0.001
24	0.094	0.396	0.009	0.086	0.197	0.265	0	0.458	0	0.001	0	0.009
25	0.004	0.419	0	0.081	0.002	0.097	0	0.539	0.001	0.001	0	0.019
26	0.014	0.334	0	0.020	0	0.007	0.023	7.605	0	3.E-05	0	2.E-04
27	0.029	0.810	0.003	0.062	0	0.019	0	2.199	0	9.E-05	0	4.E-04
28	0.189	0.555	0.134	0.258	0.374	0.473	0	0.662	0	1.E-04	0	0.001
29	0.541	0.906	0.054	0.156	0.231	0.349	0	1.718	0	1.E-04	0	0.001
30	0.002	0.336	2E-04	0.133	0	0.108	0	0.496	0	2.E-04	0	0.001
31	0.001	0.306	0.016	0.146	0.008	0.128	0.022	0.605	0	2.E-04	0.01	0.012
32	1.76	2.363	0.109	0.208	0	0.064	0	0.388	0	3.E-04	0	0.001
33	0.002	0.305	6E-05	0.109	0.009	0.091	0.011	0.443	0	4.E-04	0	0.001
34	0.552	0.957	0	0.093	0.133	0.236	0.144	0.978	0	2.E-04	0.047	0.057
35	0.003	0.295	3E-04	0.050	0	0.019	0	0.411	0	7.E-05	0	3.E-04
36	0.017	0.501	0.002	0.123	0	0.025	0	0.397	0	3.E-04	0	0.001
37	0.026	0.247	0.001	0.066	0	0.031	0	0.568	0	1.E-04	0	5.E-04
38	0.078	0.483	5E-05	0.084	0.011	0.037	0	0.494	0	9.E-05	0	3.E-04
39	0.013	0.304	9E-05	0.119	0	0.031	0	0.456	0	2.E-04	0	4.E-04
40	0.004	0.260	0	0.076	0.005	0.030	0	0.376	0	1.E-04	0	0.001
41	2E-04	0.221	1E-05	0.074	2E-04	0.029	0	0.385	0	2.E-04	0	0.001
42	2E-05	0.202	1E-06	0.070	3E-05	0.025	0	0.376	0	2.E-04	0	0.001
43	0.001	0.209	8E-05	0.066	0	0.025	0	0.339	0	1.E-04	0	0.001
44	1E-06	0.207	1E-07	0.065	0	0.030	0	0.344	0	2.E-04	0	0.002
45	0.003	0.238	3E-04	0.076	0	0.057	0	0.437	0	3.E-04	0	0.003
46	4E-05	0.160	3E-06	0.054	2E-05	0.032	0	0.224	0	1.E-04	0	0.001
47	1E-04	0.197	1E-05	0.059	9E-05	0.026	0	0.272	0	7.E-05	0	0.001
48	0.005	0.213	3E-04	0.080	0.003	0.036	0	0.329	0	1.E-04	0	0.001
49	0.059	0.261	0.004	0.070	0.052	0.097	0	0.362	0	2.E-04	0	0.001
50	0.282	0.501	0.019	0.097	0.028	0.054	0	0.332	0	2.E-04	0	4.E-04
51	0.003	0.199	3E-04	0.072	0	0.038	0	0.366	0	2.E-04	0	0.001
52	0	0.169	0	0.047	0	0.016	0	0.277	0	7.E-05	0	0.001
53	0.41	0.998	0.6	0.801	0.072	0.103	0	1.090	0	6.E-05	0	4.E-04
54	0	0.088	0	0.052	0	0.010	0	0.146	0	2.E-05	0	1.E-04
55	4E-04	0.167	4E-05	0.067	0	0.021	0	0.858	0	1.E-04	0	0.001
56	0	0.086	0	0.022	0	0.009	0	0.098	0	8.E-05	0	3.E-04

D-Direct Pollution Intensity, D-I Total (Direct Plus Indirect) Pollution Intensity. For sectors and pollutants specification, see appendices 3.1 and 3.2

Poll.→ Sec.↓	7 D	7 D-I	8 D	8 D-I	9 D	9 D-I	10 D	10 D-I	11 D	11 D-I	12 D	12 D-I
1	0	0.003	0	0.010	0	0.001	0	0.002	0	5.E-05	0	2.E-07
2	0.012	0.013	0.069	0.074	0.002	0.002	0	4.E-04	0	2.E-05	0	1.E-07
3	0.004	0.005	0.007	0.012	0	4.E-04	0	4.E-04	0	2.E-05	0	1.E-07
4	0	5.E-04	0	0.003	0	1.E-04	0	6.E-05	0	2.E-05	0	2.E-07
5	0	0.001	0	0.012	0	0.001	0	2.E-04	0	2.E-04	0	5.E-07
6	0	5.E-04	0	0.003	0	2.E-04	0	8.E-05	0	3.E-05	0	8.E-08
7	4E-04	0.001	0.003	0.013	1E-04	0.001	0.001	0.001	0.001	0.001	0	7.E-07
8	0.002	0.003	0.02	0.025	0.001	0.001	0.004	0.004	0.008	0.008	0	4.E-07
9	3E-04	0.003	0.004	0.015	8E-05	0.001	0	0.001	1E-05	7.E-05	0	2.E-07
10	0.002	0.005	0.005	0.022	1E-04	0.001	0	0.001	0	4.E-05	0	3.E-07
11	0.001	0.005	0.001	0.025	7E-05	0.001	0	0.001	0	4.E-05	0	5.E-07
12	0.097	0.101	0	0.023	0	0.001	0.002	0.003	0	1.E-04	0	5.E-07
13	2E-04	0.003	0.001	0.029	8E-05	0.001	0	3.E-04	0	3.E-05	0	3.E-07
14	0.002	0.009	0.02	0.048	0.001	0.002	0	4.E-04	0	4.E-05	0	6.E-07
15	0.002	0.008	0.013	0.043	0.001	0.002	0	2.E-04	0	4.E-05	0	5.E-07
16	2E-06	0.005	1E-05	0.020	5E-07	0.001	3E-06	2.E-04	5E-06	4.E-05	0	4.E-07
17	0.03	0.050	0.078	0.146	0	0.001	0	2.E-04	0	5.E-05	0	5.E-07
18	1E-04	0.002	3E-04	0.016	2E-05	0.001	0	5.E-04	0	5.E-05	0	7.E-07
19	2E-05	0.002	2E-04	0.012	8E-06	5.E-04	4E-05	1.E-04	8E-05	1.E-04	0	4.E-07
20	0.025	0.036	0.325	0.433	0	0.002	0	3.E-04	0	8.E-05	0	6.E-07
21	0	0.011	0	0.117	0	0.001	0	2.E-04	0	5.E-05	0	5.E-07
22	2E-04	0.005	0.001	0.023	7E-05	0.001	0	2.E-04	0	4.E-05	0	5.E-06
23	0.005	0.012	0.013	0.039	0	0.001	0	2.E-04	0	4.E-05	0	7.E-07
24	0.005	0.020	0.023	0.077	0	0.001	7E-05	4.E-04	0	6.E-05	9E-05	1.E-04
25	0	0.027	0	0.087	0	0.001	0	2.E-04	0	5.E-05	0	8.E-07
26	4E-04	0.001	0.002	0.007	1E-04	0.001	0.001	0.001	0	3.E-05	0	2.E-07
27	0.001	0.003	0	0.015	3E-04	0.001	0.001	0.002	0	1.E-04	0	7.E-07
28	0.04	0.052	0.111	0.165	0.001	0.003	0	0.001	0	2.E-04	0	5.E-07
29	0.019	0.032	0.022	0.064	0.005	0.008	0.027	0.031	0	0.001	0	5.E-07
30	0.001	0.015	0.002	0.064	0	0.003	0	0.001	0	1.E-04	0	5.E-07
31	0.006	0.020	0.039	0.098	0.001	0.003	0	3.E-04	0	1.E-04	0	5.E-07
32	0.104	0.135	0.468	0.615	0.041	0.051	0	2.E-04	0	7.E-05	0	7.E-07
33	0	0.010	0	0.053	0	0.002	0	0.001	0	9.E-05	0	5.E-07
34	0.055	0.076	0.144	0.222	0	0.001	0	3.E-04	0	8.E-05	0	5.E-07
35	1E-04	0.003	0.001	0.019	3E-05	0.001	0	0.001	3E-04	0.002	0	5.E-07
36	5E-04	0.003	0.004	0.027	2E-04	0.002	0.001	0.002	0.002	0.003	0	7.E-07
37	3E-04	0.004	0.001	0.021	0	0.001	0	0.001	0	0.001	0	5.E-07
38	0.002	0.005	0.004	0.022	0	0.001	0.002	0.004	0	2.E-04	0	6.E-07
39	0	0.003	0	0.022	4E-05	0.002	0	0.001	0	3.E-04	0	5.E-07
40	7E-05	0.003	0.001	0.019	0	0.001	0	0.001	0	2.E-04	0	6.E-07
41	3E-06	0.003	4E-05	0.019	0	0.001	0	0.001	0	8.E-05	0	3.E-06
42	3E-07	0.003	4E-06	0.019	0	0.001	0	0.001	0	8.E-05	0	8.E-07
43	4E-06	0.003	1E-05	0.017	0	0.001	0	0.001	0	8.E-05	0	7.E-07
44	4E-08	0.005	3E-07	0.025	1E-08	0.001	7E-08	0.001	1E-07	1.E-04	0	5.E-07
45	0	0.009	0	0.037	0	0.001	0	4.E-04	0	1.E-04	0	6.E-07
46	6E-07	0.005	4E-06	0.025	3E-07	0.001	0	5.E-04	0	6.E-05	0	3.E-07
47	2E-06	0.004	1E-05	0.017	1E-06	0.001	0	0.001	0	7.E-05	0	4.E-07
48	7E-05	0.004	5E-04	0.022	4E-05	0.001	0	0.001	0	8.E-05	0	4.E-06
49	0.001	0.005	0.008	0.032	0	0.001	0	0.001	0	7.E-05	0	3.E-06
50	0.014	0.019	0.041	0.066	0	0.001	0	5.E-04	0	6.E-05	0	5.E-07
51	8E-05	0.005	0.001	0.027	3E-05	0.001	1E-04	0.001	3E-04	5.E-04	0	6.E-07
52	0	0.002	0	0.014	0	0.001	0	0.001	0	0.001	0	5.E-07
53	0	0.002	0.053	0.078	9E-03	0.012	0	2.E-04	0	6.E-05	0	5.E-07
54	0	0.001	0	0.008	0	0.001	0	1.E-04	0	9.E-05	0	1.E-07
55	1E-05	0.002	1E-04	0.016	4E-06	0.001	2E-05	3.E-04	4E-05	9.E-05	0	3.E-06
56	0	0.003	0	0.016	0	0.001	0	1.E-04	0	3.E-05	0	2.E-07

Poll.→	13		14		15		16		17		18	
Sec.↓	**D**	**D-I**	**D**	**D-I**	**D**	**D-I**	**D**	**D-I**	**D**	**D-I**	**D**	**D-I**
1	0	4.E-04	0	3.E-04	0	2.E-04	0	0.107	0	6.E-05	0	0.008
2	0	1.E-04	0	8.E-05	0	1.E-04	0	0.039	0	3.E-05	0	0.003
3	0	1.E-04	0	8.E-05	0	1.E-04	0	0.038	0	3.E-05	0	0.003
4	0	3.E-06	0	3.E-06	0	4.E-04	0	0.070	0	1.E-04	0	0.002
5	0	7.E-06	0	6.E-06	0.01	0.011	0	0.154	0	1.E-04	0.341	0.354
6	0	3.E-06	0	2.E-06	0	2.E-04	5.256	5.341	0	5.E-05	0.059	0.062
7	0	6.E-06	0	5.E-06	4E-05	4.E-04	0.012	0.208	6E-05	1.E-04	0.012	0.020
8	0	5.E-06	0	4.E-06	2E-04	5.E-04	0.081	0.168	4E-04	5.E-04	0.081	0.084
9	0	2.E-04	0	2.E-04	0	3.E-04	0	0.121	0	7.E-05	0	0.008
10	0	3.E-04	0	2.E-04	0	0.001	0	0.123	0	1.E-04	0	0.010
11	0	1.E-04	0	1.E-04	0	5.E-04	0	0.143	0	1.E-04	0	0.008
12	0	6.E-05	0	5.E-05	0	0.001	0.01	0.134	0	1.E-04	0.011	0.023
13	0	6.E-05	0	5.E-05	0	5.E-04	0	0.089	0	1.E-04	0	0.007
14	0	9.E-05	0	7.E-05	0	0.004	0.003	0.159	6E-06	0.001	0	0.010
15	0	4.E-05	0	3.E-05	0	0.004	0.002	0.150	4E-06	0.001	0	0.011
16	0	3.E-05	0	2.E-05	2E-07	0.002	0	0.116	0	4.E-04	0	0.008
17	0	4.E-05	0	3.E-05	0	0.004	0	0.185	0	0.001	0	0.014
18	0	9.E-05	0	7.E-05	0	0.001	2E-04	0.187	0	2.E-04	0	0.013
19	0	7.E-06	0	5.E-06	2E-06	0.001	0.001	0.086	4E-06	3.E-04	0.001	0.006
20	0	3.E-05	0	3.E-05	0	0.003	0	0.184	0	5.E-04	0	0.036
21	0	2.E-05	0	1.E-05	0	0.007	0	0.131	0	0.002	0	0.015
22	0	3.E-05	0	2.E-05	0	0.004	0	0.115	0	0.001	0	0.007
23	0	3.E-05	0	2.E-05	0	0.007	0.029	0.147	0	0.002	0	0.007
24	0	6.E-05	0	5.E-05	0	0.003	0	0.219	0	0.001	0	0.015
25	0	3.E-05	0	2.E-05	0	0.004	0.001	0.247	0	0.001	0	0.014
26	0	6.E-06	0	4.E-06	0	0.001	0	3.875	0	1.E-04	0	0.047
27	0	1.E-05	0	1.E-05	0	0.003	0	1.124	0	2.E-04	0	0.108
28	0	2.E-04	0	1.E-04	0	0.002	0	0.338	0	3.E-04	0	0.030
29	0.007	0.008	0.005	0.006	0	0.001	0.005	0.888	0	0.001	0.061	0.101
30	0	3.E-04	0	2.E-04	0	0.001	0.001	0.254	0	3.E-04	0.001	0.022
31	0	5.E-05	0	4.E-05	0.211	0.223	0	0.296	0.058	0.061	0	0.021
32	0	3.E-05	0	3.E-05	0	0.001	0	0.197	0	2.E-04	0	0.013
33	0	1.E-04	0	8.E-05	1E-09	0.002	0	0.218	0	0.001	4E-05	0.019
34	0	5.E-05	0	4.E-05	0	0.005	0	0.410	0	0.001	0	0.022
35	0	1.E-05	0	9.E-06	1E-05	0.002	0	0.224	0	5.E-04	0	0.048
36	0	1.E-05	0	9.E-06	5E-05	0.002	0	0.212	0	2.E-04	0	0.065
37	0	1.E-05	0	1.E-05	2E-07	0.001	0	0.300	4E-06	3.E-04	0	0.032
38	0	9.E-06	0	7.E-06	0	0.002	7E-05	0.253	0	2.E-04	0	0.046
39	0	1.E-05	0	9.E-06	3E-05	0.001	0	0.235	2E-05	3.E-04	0.039	0.078
40	0	1.E-05	0	8.E-06	0	0.002	0	0.193	0	4.E-04	0	0.030
41	0	1.E-05	0	8.E-06	0	0.002	0	0.196	0	5.E-04	0	0.020
42	0	1.E-05	0	8.E-06	0	0.002	0	0.191	0	3.E-04	0	0.018
43	0	9.E-06	0	7.E-06	3E-07	0.002	0	0.172	3E-08	4.E-04	0	0.019
44	0	1.E-05	0	9.E-06	4E-09	0.002	1E-06	0.172	7E-09	5.E-04	1E-06	0.021
45	0	2.E-05	0	2.E-05	0	0.001	0	0.220	1E-05	3.E-04	0	0.026
46	0	2.E-05	0	1.E-05	0	0.019	0	0.113	0	0.005	0	0.011
47	0	9.E-06	0	7.E-06	0	0.003	0	0.138	0	0.001	0	0.017
48	0	1.E-05	0	9.E-06	0	0.003	0	0.166	0	0.001	0	0.017
49	0	1.E-05	0	9.E-06	0	0.002	0	0.183	0	0.001	0	0.014
50	0	1.E-05	0	8.E-06	0	0.001	0	0.169	0	3.E-04	0	0.015
51	0	2.E-05	0	1.E-05	8E-06	0.002	0	0.186	0	4.E-04	0	0.020
52	0	2.E-05	0	2.E-05	0	0.005	0	0.146	0	0.001	0	0.021
53	0	7.E-06	0	6.E-06	0	0.002	0	0.556	0	1.E-04	0	0.065
54	0	8.E-06	0	6.E-06	0	0.001	0	0.075	0	2.E-04	0	0.007
55	0	2.E-05	0	1.E-05	1E-06	0.001	0	0.437	0	2.E-04	0	0.014
56	0	1.E-05	0	1.E-05	0	4.E-04	0	0.050	0	9.E-05	0	0.004

Poll.→	19		20		21		22		23		24	
Sec.↓	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I
1	0	7.E-05	0	3.E-06	0	3.E-06	0	3.E-07	0	4.E-05	0	3.E-06
2	0	2.E-05	0	3.E-06	0	2.E-06	0	2.E-07	0	1.E-05	0	2.E-06
3	0	2.E-05	0	4.E-06	0	2.E-06	0	3.E-07	0	1.E-05	0	2.E-06
4	0	6.E-06	0	4.E-06	0	1.E-05	0	4.E-07	0	2.E-06	0	8.E-06
5	0	9.E-06	0	2.E-05	0	8.E-06	0	2.E-06	0	1.E-05	0	7.E-06
6	0	3.E-06	0	8.E-06	0	4.E-06	0	6.E-07	0	3.E-06	0	4.E-06
7	2E-05	3.E-05	1E-05	2.E-05	1E-06	7.E-06	2E-06	3.E-06	6E-05	6.E-05	1E-07	5.E-06
8	2E-04	2.E-04	8E-05	9.E-05	8E-06	1.E-05	2E-05	2.E-05	4E-04	4.E-04	8E-07	4.E-06
9	0	4.E-05	0	7.E-06	0	5.E-06	0	6.E-07	0	3.E-05	0	4.E-06
10	0	5.E-05	0	7.E-06	0	9.E-06	0	6.E-07	0	3.E-05	0	8.E-06
11	0	3.E-05	0	8.E-06	0	8.E-06	0	6.E-07	0	2.E-05	0	6.E-06
12	0	2.E-05	0	1.E-05	0	1.E-05	0	1.E-06	0	1.E-05	0	9.E-06
13	0	1.E-05	0	1.E-05	0	8.E-06	0	9.E-07	0	1.E-05	0	7.E-06
14	3E-05	9.E-05	5E-07	1.E-05	0	8.E-05	0	2.E-06	0	1.E-05	0	6.E-05
15	2E-05	8.E-05	3E-07	1.E-05	0	1.E-04	0	2.E-06	0	1.E-05	0	8.E-05
16	0	3.E-05	0	1.E-05	0	4.E-05	0	1.E-06	0	8.E-06	0	3.E-05
17	0	5.E-05	0	1.E-05	0	8.E-05	0	2.E-06	0	1.E-05	0	7.E-05
18	0	2.E-05	0	1.E-05	0	1.E-05	0	1.E-06	0	1.E-05	0	1.E-05
19	2E-06	2.E-05	8E-07	9.E-06	8E-08	2.E-05	2E-07	1.E-06	4E-06	9.E-06	8E-09	2.E-05
20	0	3.E-05	0	1.E-05	0	4.E-05	0	1.E-06	0	1.E-05	0	3.E-05
21	0	8.E-05	0	1.E-05	0	2.E-04	0	3.E-06	0	8.E-06	0	1.E-04
22	0	2.E-04	0	1.E-05	0	1.E-04	0	2.E-06	0	1.E-05	0	8.E-05
23	0.001	1.E-03	0	1.E-05	0	2.E-04	0	3.E-06	0	1.E-05	0	1.E-04
24	0	5.E-05	0	1.E-05	0	6.E-05	0	2.E-06	0	1.E-05	0	5.E-05
25	0	4.E-05	0	1.E-05	0	8.E-05	0	2.E-06	0	9.E-06	0	6.E-05
26	0	7.E-06	0	8.E-06	0	1.E-05	0	7.E-07	4E-06	8.E-06	0	9.E-06
27	0	1.E-05	1E-04	2.E-04	0	1.E-05	6E-06	7.E-06	0	1.E-05	0	1.E-05
28	0	4.E-05	0	2.E-05	0	2.E-05	0	2.E-06	0	4.E-05	0	2.E-05
29	0.001	0.001	0	2.E-05	0	1.E-05	0	2.E-06	0.001	0.001	0	1.E-05
30	0	6.E-05	0	2.E-05	0	3.E-05	0	2.E-06	0	5.E-05	0	2.E-05
31	0.002	0.003	0	2.E-05	0.005	0.005	6E-05	7.E-05	0	2.E-05	0.004	0.004
32	0	1.E-05	0.001	0.001	2E-05	4.E-05	2E-05	3.E-05	0.001	0.001	0	9.E-05
33	4E-06	4.E-05	0	1.E-05	0	4.E-05	0	2.E-06	0	2.E-05	0	4.E-05
34	0	6.E-05	0	1.E-05	0	1.E-04	0	2.E-06	0	1.E-05	0	9.E-05
35	0	5.E-05	0	3.E-05	0	3.E-05	0	4.E-06	0	8.E-05	0	3.E-05
36	0	3.E-05	0	3.E-05	0	1.E-05	0	3.E-06	0	6.E-05	0	9.E-06
37	0	3.E-05	0	2.E-05	3E-06	2.E-05	0	3.E-06	0	6.E-05	0	2.E-05
38	0	1.E-05	4E-04	0.001	0	1.E-05	3E-05	5.E-05	0	2.E-05	0	1.E-05
39	1E-07	2.E-05	0	7.E-05	4E-07	2.E-05	0	6.E-06	0	2.E-05	0	2.E-05
40	0	2.E-05	0	2.E-04	0	4.E-05	0	1.E-05	0	2.E-05	0	3.E-05
41	0	2.E-05	0	1.E-04	0	4.E-05	0	9.E-06	0	1.E-05	0	3.E-05
42	0	2.E-05	0	1.E-04	0	3.E-05	0	8.E-06	0	1.E-05	0	2.E-05
43	0	2.E-05	0	1.E-04	0	3.E-05	0	1.E-05	0	1.E-05	0	3.E-05
44	3E-09	2.E-05	1E-09	8.E-05	0	4.E-05	0	6.E-06	7E-09	1.E-05	0	3.E-05
45	0	2.E-05	0	4.E-05	3E-07	2.E-05	0	3.E-06	0	1.E-05	5E-08	2.E-05
46	0	2.E-04	0	7.E-05	0	4.E-04	0	1.E-05	0	1.E-05	0	4.E-04
47	0	3.E-05	0	1.E-04	0	5.E-05	0	1.E-05	0	7.E-06	0	4.E-05
48	0	3.E-05	0	9.E-05	0	6.E-05	0	7.E-06	0	1.E-05	0	5.E-05
49	0	3.E-05	0	8.E-05	0	5.E-05	0	7.E-06	0	1.E-05	0	4.E-05
50	0	1.E-05	0	7.E-05	0	2.E-05	0	5.E-06	0	9.E-06	0	2.E-05
51	0	3.E-05	0	6.E-05	0	3.E-05	0	5.E-06	0	2.E-05	0	3.E-05
52	0	6.E-05	0	7.E-05	0	1.E-04	0	7.E-06	0	3.E-05	0	8.E-05
53	0	7.E-06	0	1.E-05	0	8.E-06	0	1.E-06	0	7.E-06	0	7.E-06
54	0	1.E-05	0	1.E-05	0	2.E-05	0	1.E-06	0	6.E-06	0	2.E-05
55	0	1.E-05	0	1.E-05	0	1.E-05	0	1.E-06	0	8.E-06	0	1.E-05
56	0	7.E-06	0	2.E-05	0	8.E-06	0	1.E-06	0	2.E-05	0	8.E-06

Poll.→ Sec.↓	25 D	25 D-I	26 D	26 D-I	27 D	27 D-I	28 D	28 D-I	29 D	29 D-I	30 D	30 D-I
1	0	8.E-08	0	0.009	0	0.012	0	2.E-06	0	1.E-06	0	0.054
2	0	6.E-08	0	0.002	0	0.004	0	1.E-06	0	5.E-07	0	0.020
3	0	1.E-07	0	0.002	0	0.004	0	1.E-06	0	4.E-07	0	0.019
4	0	3.E-08	0	6.E-05	0	0.007	0	4.E-06	0	1.E-06	0	0.036
5	0	3.E-07	0	2.E-04	0.043	0.060	0	9.E-06	0	4.E-06	0	0.078
6	0	5.E-08	0	6.E-05	0.541	0.549	0	2.E-06	0	8.E-07	2.686	2.730
7	1E-06	1.E-06	2E-05	1.E-04	0	0.021	4E-05	4.E-05	2E-05	2.E-05	0	0.100
8	8E-06	8.E-06	2E-04	3.E-04	0	0.009	2E-04	2.E-04	2E-04	2.E-04	0	0.045
9	0	1.E-07	0	0.005	0	0.013	0	3.E-06	0	1.E-06	0	0.061
10	0	1.E-07	0	0.005	0	0.014	0	5.E-06	0	2.E-06	0	0.062
11	0	2.E-07	0	0.003	0	0.015	0	4.E-06	0	1.E-06	0	0.073
12	0	2.E-07	0	0.001	0	0.014	0	7.E-06	0	3.E-06	0	0.063
13	0	2.E-07	0	0.001	0	0.010	0	4.E-06	0	1.E-06	0	0.045
14	0	1.E-07	0	0.002	0	0.017	0	3.E-05	0	7.E-06	0	0.079
15	0	1.E-07	0	0.001	0	0.016	0	4.E-05	0	8.E-06	0	0.075
16	0	1.E-07	0	0.001	0	0.013	0	1.E-05	0	3.E-06	0	0.059
.17	0	2.E-07	0	0.001	0	0.020	0	3.E-05	0	8.E-06	0	0.094
18	0	1.E-07	0	0.002	0	0.021	0	6.E-06	0	2.E-06	0	0.095
19	8E-08	2.E-07	2E-06	1.E-04	0	0.009	2E-06	1.E-05	2E-06	4.E-06	0	0.043
20	0	2.E-07	0	0.001	0	0.023	0	2.E-05	0	5.E-06	0	0.094
21	0	1.E-07	0	3.E-04	0	0.015	0	6.E-05	0	1.E-05	0	0.067
22	0	2.E-07	0	0.001	0	0.012	0	4.E-05	0	9.E-06	0	0.055
23	0	2.E-07	0	0.001	0	0.012	0	7.E-05	0	1.E-05	0	0.055
24	0	2.E-07	0	0.001	0	0.024	0	2.E-05	0	6.E-06	0	0.111
25	0	1.E-07	0	0.001	0	0.027	0	3.E-05	0	7.E-06	0	0.126
26	0	8.E-08	0	1.E-04	0	0.399	0	5.E-06	0	1.E-06	0	1.981
27	0	2.E-07	0	3.E-04	0	0.127	0	8.E-06	0	3.E-06	0	0.574
28	0	5.E-07	0	0.003	0	0.038	0	2.E-05	0	6.E-06	0	0.172
29	0	8.E-07	0.139	0.159	0.007	0.101	0	2.E-05	0	1.E-05	0	0.448
30	0	6.E-07	0	0.006	0	0.028	0	1.E-05	0	4.E-06	0.003	0.132
31	0	3.E-07	0	0.001	0.002	0.034	0.002	0.002	0	4.E-04	3E-04	0.151
32	2E-05	3.E-05	0	0.001	0	0.021	0	8.E-06	0	2.E-06	0	0.100
33	2E-07	5.E-07	0	0.002	1.00E-05	0.024	0	2.E-05	0	5.E-06	3E-05	0.111
34	0	2.E-07	0	0.001	0	0.044	0	4.E-05	0	1.E-05	0	0.209
35	0	2.E-06	0	3.E-04	0	0.025	0	6.E-05	0	3.E-05	0	0.107
36	0	1.E-06	0	3.E-04	0	0.027	0	4.E-05	0	2.E-05	0	0.103
37	0	1.E-06	0	3.E-04	0	0.032	0	4.E-05	5E-07	2.E-05	0	0.148
38	0	3.E-07	0	2.E-04	0	0.031	0	1.E-05	0	5.E-06	0	0.128
39	0	4.E-07	2E-05	3.E-04	0	0.027	3E-07	2.E-05	0	7.E-06	0	0.118
40	0	3.E-07	0	2.E-04	0	0.022	0	2.E-05	0	7.E-06	0	0.098
41	0	2.E-07	0	2.E-04	0	0.022	0	2.E-05	0	5.E-06	0	0.100
42	0	2.E-07	0	2.E-04	0	0.021	0	1.E-05	0	4.E-06	0	0.097
43	0	2.E-07	0	2.E-04	0	0.019	0	1.E-05	0	4.E-06	0	0.088
44	0	2.E-07	3E-09	2.E-04	0	0.019	4E-09	2.E-05	3E-09	5.E-06	0	0.088
45	0	2.E-07	0	4.E-04	0	0.024	0	1.E-05	0	4.E-06	0	0.112
46	0	3.E-07	0	3.E-04	0	0.013	0	2.E-04	0	4.E-05	0	0.057
47	0	1.E-07	0	2.E-04	0	0.016	0	2.E-05	0	5.E-06	0	0.070
48	0	2.E-07	0	2.E-04	0	0.019	0	2.E-05	0	6.E-06	0	0.085
49	0	2.E-07	0	2.E-04	0	0.020	0	2.E-05	0	5.E-06	0	0.093
50	0	2.E-07	0	2.E-04	0	0.019	0	1.E-05	0	3.E-06	0	0.086
51	0	3.E-07	0	4.E-04	0	0.020	0	2.E-05	0	7.E-06	0	0.094
52	0	6.E-07	0	4.E-04	0	0.016	0	5.E-05	0	2.E-05	0	0.072
53	0	1.E-07	0	2.E-04	0	0.065	0	5.E-06	0	2.E-06	0	0.284
54	0	1.E-07	0	2.E-04	0	0.008	0	1.E-05	0	3.E-06	0	0.038
55	0	1.E-07	0	4.E-04	0	0.046	0	7.E-06	0	2.E-06	0	0.223
56	0	4.E-07	0	3.E-04	0	0.005	0	4.E-06	0	1.E-06	0	0.025

Poll.→	31		32		33		34		35		36	
Sec.↓	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I	D	D-I
1	0	2.E-06	0	0.004	0	9.E-07	0	2.E-04	0	0.002	0	4.E-06
2	0	9.E-07	0	0.001	0	1.E-06	0	1.E-04	0	0.001	0	9.E-07
3	0	9.E-07	0	0.001	0	1.E-06	0	9.E-05	0	0.001	0	8.E-07
4	0	2.E-06	0	0.002	0	7.E-07	0	3.E-04	0	0.001	0	4.E-08
5	0	7.E-06	0.025	0.031	0	2.E-06	0.008	0.008	0.213	0.219	0	7.E-08
6	0	2.E-06	0.174	0.177	0	8.E-07	0	2.E-04	0	0.001	0	3.E-08
7	4E-05	4.E-05	0	0.007	0	1.E-06	0	3.E-04	0	0.003	0	6.E-08
8	2E-04	2.E-04	0	0.003	0	9.E-07	0	2.E-04	0	0.001	0	5.E-08
9	0	3.E-06	0	0.004	0	3.E-06	0	2.E-04	0	0.003	0	2.E-06
10	0	3.E-06	0	0.004	0	2.E-06	0	4.E-04	0	0.004	0	2.E-06
11	0	3.E-06	0	0.005	0	1.E-05	0	3.E-04	0	0.003	0	1.E-06
12	0	5.E-06	0	0.005	0.025	0.025	0	0.001	0	0.006	0	5.E-07
13	0	3.E-06	0	0.003	0	4.E-06	0	4.E-04	0	0.003	0	5.E-07
14	0	2.E-05	0	0.006	0	4.E-06	0	0.003	0	0.005	0	8.E-07
15	0	2.E-05	0	0.005	0	4.E-06	0	0.003	0	0.005	0	3.E-07
16	0	8.E-06	0	0.004	0	3.E-06	0	0.001	0	0.003	0	3.E-07
17	0	2.E-05	0	0.007	0	5.E-06	0	0.003	0	0.007	0	3.E-07
18	0	4.E-06	0	0.007	0	3.E-06	0	0.001	0	0.006	0	8.E-07
19	2E-06	8.E-06	0	0.003	0	2.E-06	0	0.001	0	0.002	0	7.E-08
20	0	1.E-05	0	0.008	0	4.E-06	0	0.002	0	0.021	0	4.E-07
21	0	4.E-05	0	0.005	0	3.E-06	0	0.005	0	0.007	0	2.E-07
22	0	2.E-05	0	0.004	0	4.E-06	0	0.003	0	0.003	0	2.E-07
23	0	4.E-05	0	0.004	0	5.E-06	0	0.005	0	0.003	0	3.E-07
24	0	1.E-05	0	0.008	0	5.E-06	0	0.002	0	0.007	0	6.E-07
25	0	2.E-05	0	0.009	0	6.E-06	0	0.003	0	0.006	0	3.E-07
26	0	3.E-06	0	0.129	0	2.E-06	0	0.000	0	0.002	0	6.E-08
27	0	6.E-06	0	0.044	0	5.E-06	0	0.003	0	0.058	0	1.E-07
28	0	1.E-05	0	0.013	0	4.E-06	0	0.001	0	0.014	0	2.E-06
29	0	2.E-05	0	0.030	0	3.E-06	0	0.001	0	0.009	0	6.E-07
30	0	9.E-06	0	0.009	0	4.E-06	0	0.001	0	0.008	3E-04	4.E-04
31	0.001	0.001	8E-05	0.011	0	1.E-05	0.153	0.162	0	0.010	0	6.E-07
32	0	5.E-06	0	0.007	0	6.E-06	0	0.001	0	0.006	0	4.E-07
33	0	1.E-05	0	0.008	2E-07	5.E-06	4E-09	0.002	0	0.009	0	1.E-06
34	0	3.E-05	0	0.015	0	1.E-05	0	0.004	0	0.010	0	4.E-07
35	0	5.E-05	0	0.009	0	3.E-06	0	0.002	0	0.019	0	1.E-07
36	0	4.E-05	0	0.010	0	3.E-06	0	0.002	0	0.032	0	1.E-07
37	0	4.E-05	0	0.011	0	3.E-06	0	0.001	0	0.011	0	2.E-07
38	0	9.E-06	0	0.011	0	4.E-06	0	0.001	0	0.024	0	1.E-07
39	0	1.E-05	0	0.009	0	3.E-06	0	0.001	0	0.014	0	1.E-07
40	0	1.E-05	0	0.008	0	4.E-06	0	0.002	0	0.012	0	1.E-07
41	0	1.E-05	0	0.008	0	4.E-06	0	0.002	0	0.009	0	1.E-07
42	0	8.E-06	0	0.007	0	5.E-06	0	0.001	0	0.008	0	1.E-07
43	0	9.E-06	0	0.007	0	4.E-06	0	0.001	0	0.009	0	1.E-07
44	4E-09	1.E-05	0	0.007	0	4.E-06	0	0.001	0	0.007	0	1.E-07
45	0	8.E-06	0	0.008	0	4.E-06	0	0.001	0	0.007	0	3.E-07
46	0	1.E-04	0	0.004	0	8.E-06	0	0.014	0	0.005	0	2.E-07
47	0	1.E-05	0	0.006	0	3.E-06	0	0.002	0	0.008	0	1.E-07
48	0	1.E-05	0	0.006	0	4.E-06	0	0.002	0	0.008	0	1.E-07
49	0	1.E-05	0	0.007	0	4.E-06	0	0.002	0	0.006	0	1.E-07
50	0	6.E-06	0	0.006	0	4.E-06	0	0.001	0	0.006	0	1.E-07
51	0	1.E-05	0	0.007	0	3.E-06	0	0.001	0	0.006	0	2.E-07
52	0	4.E-05	0	0.006	0	3.E-06	0	0.003	0	0.008	0	5.E-07
53	0	3.E-06	0	0.023	0	3.E-06	0	0.002	0	0.036	0	7.E-08
54	0	7.E-06	0	0.003	0	1.E-06	0	0.001	0	0.003	0	1.E-07
55	0	4.E-06	0	0.015	0	4.E-06	0	0.001	0	0.005	0	2.E-07
56	0	2.E-06	0	0.002	0	1.E-05	0	0.000	0	0.002	0	1.E-07

It is important to note that these sectors were marked for their very low direct pollution intensity. In the same way, cement (36), printing and publishing (21) which were discharging zero/negligible pollution directly, have important environmental implications when their indirect pollution intensity is taken into account. Similarly, agriculture (1), construction (52) industry have also generated significant pollution indirectly. The table shows that sectors such as tobacco product (13), leather footwear (22), non-ferrous basic metal (39), petroleum product (26) have low direct pollution intensity, but the indirect effects have generally been high for these sectors. As a result, all these sectors are in the high intensity range. This implies that the inputs used by these sectors are highly polluting. Sectors under this category in which they generate low pollution intensity directly but high intensity indirectly should be given appropriate treatment in policy framework. Generally sectors with low direct pollution potentials are considered environmentally safe. The indirect contribution of low polluting sectors is completely ignored in policy formulation. Input-output technique proves to be very effective for the pollution assessment of this type of sectors.

Although dairy (2), other livestock product (3), sugar (9), leather (23), edible oil (10), beverages (12) sectors come under highly polluting category, their indirect effect is comparatively lower than the other sectors of the input-output table. These sectors are a cause of concern because of their high direct pollution potentials. The direct effect generated by these sectors is very significant and hence they are under the highly polluting category. Indirect effect is not that important for these sectors as is in the case of other sectors. These sectors are cause of concern because of their direct pollution generation.

In the case of other pollutants also more or less the same trend has been followed. For suspended insoluble solids (2-6), electricity (53), pesticides (30), paint varnishes(31), heavy chemicals (28), cement (36), non-ferrous basic metals (39), paper (20), other chemicals (33), fertilizer (29) have been highest in terms of indirect pollution. Other sectors have also generated significant pollution. In the case of biological oxygen demand (7), drugs (32), plastics (25), synthetic fibers (34), synthetic textiles

(17), rubber (24) have the highest indirect pollution. Similarly, for chemical oxygen demand (8), drugs (32), printing and publishing (21), paper (20), plastics (25), synthetic fibers (34) show the highest intensity. In the case of oil and greases (9) the same trend is observed. Again drugs (32) has the highest indirect effect, then followed by electricity (53), pesticides (30), fertilizer (29), heavy chemicals (28) etc.

The indirect effect of the remaining pollutants is not very significant. In all over the analysis we have observed that there are three categories of sectors— firstly, sectors which have high direct as well as indirect effect. Secondly, sectors in which the direct component is high but not the indirect. Thirdly, sectors that generate zero or negligible pollution directly but their indirect effect is highly significant. All the three categories of sectors are cause of concern and should be dealt under different policy frameworks.

4.4 Final Demand Intensity

The impulse of output change is from the changes in final demand and it is an important component of net product in an economy. Any change in output level is ultimately influenced by the category of final demand and/or vice versa. Since level of pollution directly varies with the level of output, thus, final demand becomes an important determinant of the level of pollution. For the present purpose of the analysis final demand category has six components, viz. private final consumption expenditure (PFCE), government final consumption expenditure (GFCE), gross fixed capital formation (GFCF), change in stocks (CIS), exports of goods and services (EXP) and imports of goods and services (IMP). For the present purpose GFCF and CIS have been clubbed together to form gross investment (GI) as one component. Final demand category thus now has five components.

In the preceding section we have discussed water pollution intensity of the different sectors of the input-output table. It explained that how much pollution is discharged per lakh rupees of output. Now it is also important to know that how much

pollution is generated as a result of change in final demand. After discussing the direct and indirect water pollution effects this section now aims to describe the generation of total pollution associated with the category of final demand for the entire economy. The subdivision of this kind will give a further insight into the analysis that how each component of final demand may influence the level of pollution and thereby various policies.

The following relationship describe the generation of pollution in the economy–

$$X_{yp} = A_{21}(I - A)^{-1}Y_{Pfce} \tag{4.2}$$

$$X_{ygf} = A_{21}(I - A)^{-1}Y_{Gfce} \tag{4.3}$$

$$X_{ygi} = A_{21}(I - A)^{-1}Y_{Gi} \tag{4.4}$$

$$X_{yex} = A_{21}(I - A)^{-1}Y_{Exp} \tag{4.5}$$

$$X_{ym} = A_{21}(I - A)^{-1}Y_{Imp} \tag{4.6}$$

We know that final demand category is important in determining the output level of different sectors. Since level of pollution directly varies with the change in output thus, it is important to consider the different components of final demand. Equations (4.2-4.6) measure the contribution of separate final demand components such as, private consumption (PFCE), government consumption (GFCE), gross investment (GI), exports (EXP) and imports (IMP) to the total pollution generation in a particular year 't'. For instance X_{yp} in equation (4.2) measures contribution of private consumption to the generation of different pollutants. Likewise equation (4.3-4.6) explain the effects of other components of final demand.

Equation (4.2-4.6) calculates total pollution generated directly and indirectly to produce the given final demand during 1993-94. The results related with above relationship are produced in table 4.10 to 4.12. These results show the contribution of each component of final demand in total pollution load.

As is clear from the table that private consumption expenditure has been the dominant source of pollution. however the percentage varies in the case of all different

Table 4.10: **Final Demand Intensity, 1983-84**

(Effluent quantity is in thousand cu.m. and other pollutants in tons per lakh rupees of output)

FD→ Poll↓	PFCE (BT)	PFCE (AT)	GFCE (BT)	GFCE (AT)	GI (BT)	GI (AT)
1	4353712	4353298	562440	562388	1616779	1616569
2	4740456	1065259	364905	163858	733275	410911
3	7657525	1674456	398554	53880	1769932	235142
4	28281166	5587886	3609092	721711	6825576	1354429
5	359092	33393	4109	261	42878	2220
6	127649	21971	1370	357	100470	17853
7	5441566	154195	484946	14399	1851888	42425
8	10841474	694111	1299267	90568	4386983	192738
9	352231	33787	13205	5874	-8226	8103
10	196343	19791	13629	936	102140	3170
11	875	757	238	237	1725	1722
12	327	15	29	1	392	18
13	33364	4204	460	58	-4802	-605
14	21262	3271	293	45	-3060	-471
15	57883	24083	11035	4645	79458	36541
16	14092945	2788612	1833570	367375	3329884	671539
17	12678	5832	2136	1098	17644	9254
18	1219933	210138	145898	31385	545992	132619
19	4825	1024	170	58	704	327
20	6426	346	2074	117	20897	791
21	946	477	191	94	1503	779
22	990	28	317	8	3334	70
23	5042	638	829	111	219	80
24	773	400	157	80	1228	639
25	51	6	15	2	13	3
26	667787	84152	9210	1164	-96078	-12078
27	1542894	305917	203633	40704	399819	80495
28	368	199	73	40	623	343
29	84	48	17	10	149	90
30	7080164	1415856	934963	186989	1682629	336529
31	207	115	42	24	356	205
32	506157	101236	69233	13848	147164	29441
33	266504	3731	1638	23	15556	218
34	42854	17626	8160	3395	58300	26600
35	402937	80447	73239	14646	323091	64614
36	191	20	4	0	61	6

PFCE- Private Final Consumption Expenditure, GFCE-Govt. Final Consumption Expenditure, GI- Gross Investment, BT-Before Treatment values, AT- After Treatment values. For Pollutants specification, see appendix 3.2.

FD→ Poll↓	EXP (BT)	EXP (AT)	IMP (BT)	IMP (AT)	Total (BT)	Total (AT)
1	532088	532009	1069825	1069534	5995195	5994730
2	298703	117511	510593	213980	5626745	1543559
3	708016	85785	2107219	177778	8426808	1871485
4	11171675	2226117	30976372	6192776	18911138	3697368
5	51950	4780	8108	510	449923	40144
6	5512	1133	27676	4778	207324	36536
7	665249	13464	2192016	28356	6251633	196126
8	1642632	72363	5272178	135153	12898178	914627
9	14998	3913	31240	5049	340968	46628
10	17650	1387	62005	4317	267757	20968
11	336	325	916	915	2259	2125
12	44	2	36	2	757	34
13	1195	151	3498	441	26719	3367
14	762	117	2229	343	17027	2620
15	15690	7180	15701	6205	148366	66244
16	5654092	1130849	15773473	3159939	9137018	1798436
17	3731	1827	3005	1427	33185	16583
18	184905	40115	437905	99909	1658823	314348
19	782	175	554	144	5927	1439
20	2182	102	8160	319	23419	1038
21	303	154	231	117	2711	1387
22	342	9	1294	26	3689	90
23	551	77	812	129	5829	777
24	246	127	187	97	2217	1151
25	10	1	10	2	78	10
26	23931	3020	70041	8843	534809	67415
27	593535	118625	1651167	329942	1088714	215799
28	121	67	110	69	1075	580
29	29	17	35	26	245	141
30	2875854	575151	8053315	1610654	4520295	903871
31	69	39	71	49	603	334
32	194136	38829	537382	107478	379308	75876
33	921	13	1818	25	282802	3959
34	11511	5228	11649	4534	109177	48316
35	65934	13173	131236	26246	733964	146634
36	9	1	35	4	230	24

EXP- Exports, IMP-Imports, BT-Before Treatment values, AT- After Treatment values.

Table 4.11: **Final Demand Intensity, 1989-90**

(Effluent quantity is in thousand cu.m. and other pollutants in tons per lakh rupees of output)

FD→ Poll↓	PFCE (BT)	PFCE (AT)	GFCE (BT)	GFCE (AT)	GI (BT)	GI (AT)
1	6873748	6872998	1185163	1184967	2841669	2841300
2	6568076	1749326	824127	312299	1545209	823278
3	12649984	2461769	1624226	186300	3172711	409146
4	51110590	10100491	9288165	1852995	15299425	3053519
5	572327	52822	23997	946	63561	2266
6	331130	56303	41147	7112	73318	13564
7	8667726	255740	1708100	42426	3189413	72577
8	18325129	1104581	4280264	211412	7850649	357959
9	594694	52677	35107	12185	68049	23440
10	385014	42239	31474	2466	194611	12159
11	2003	1852	648	646	4809	4803
12	527	24	83	4	646	29
13	75789	9549	2160	272	6375	803
14	48297	7430	1377	212	4062	625
15	85943	36749	20224	8742	100586	45437
16	25353393	5036178	4679725	936572	7739993	1570279
17	20987	9295	4164	2132	22203	11508
18	1957594	342228	277467	60676	965708	244025
19	9094	2069	483	145	1869	685
20	9878	522	3959	237	29627	1234
21	1471	745	371	181	1872	959
22	1529	44	601	17	4689	104
23	9366	1221	1881	262	3088	558
24	1202	622	304	156	1530	794
25	72	9	34	5	53	10
26	1516927	191163	43250	5460	127678	16166
27	2761551	546272	505635	100977	889831	177625
28	596	331	147	84	828	487
29	146	89	38	24	227	154
30	12777152	2555208	2379659	475916	3912467	782456
31	344	199	87	52	503	317
32	890653	178138	168291	33660	308536	61717
33	296682	4154	12536	176	15859	222
34	63466	26842	14917	6377	73868	33039
35	533496	106519	119327	23863	466068	93206
36	393	41	13	1	48	5

PFCE- Private Final Consumption Expenditure, GFCE-Govt. Final Consumption Expenditure, GI- Gross Investment, BT-Before Treatment values, AT- After Treatment values. For Pollutants specification, see appendix 3.2.

FD→ Poll↓	EXP (BT)	EXP (AT)	IMP (BT)	IMP (AT)	Total (BT)	Total (AT)
1	1253414	1253108	2146272	2145661	10007722	10006711
2	890229	336192	1040528	446479	8787113	2774616
3	2554777	255767	4681721	385862	15319977	2927121
4	9323561	1839311	43097975	8611948	41923766	8234368
5	138948	12801	20986	1336	777847	67499
6	48460	8715	75491	12961	418565	72733
7	2462929	47075	4554999	61376	11473170	356443
8	5985900	223771	10890853	273811	25551090	1623912
9	39484	11343	92241	10498	645092	89147
10	36000	3294	128047	13273	519052	46885
11	1012	1008	5131	5128	3341	3180
12	115	5	75	3	1296	59
13	3507	442	15738	1983	72093	9084
14	2235	344	10029	1543	45942	7068
15	43238	20559	36307	14340	213684	97147
16	4579607	916785	21934323	4423760	20418395	4036053
17	10819	5387	7031	3463	51142	24860
18	310507	70630	946796	232426	2564481	485133
19	2114	492	1827	552	11733	2839
20	3717	209	10933	483	36246	1718
21	891	453	520	269	4085	2070
22	576	20	1734	44	5661	141
23	1635	241	2268	493	13702	1789
24	725	376	422	219	3339	1729
25	29	4	20	7	168	21
26	70212	8863	315098	39796	1442969	181856
27	493860	98555	2327887	464324	2322990	459104
28	361	200	347	253	1585	848
29	88	53	142	121	357	200
30	2301333	460220	11171819	2234328	10198793	2039472
31	208	119	257	206	883	482
32	164550	32915	760266	152056	771764	154374
33	10161	142	6329	89	328910	4605
34	31613	14943	26898	10417	156966	70784
35	130872	26169	307429	61482	942336	188276
36	65	7	35	4	485	50

EXP- Exports, IMP-Imports, BT-Before Treatment values, AT- After Treatment values

Table 4.12: **Final Demand Intensity, 1993-94**

(Effluent quantity is in thousand cu.m. and other pollutants in tons per lakh rupees of output)

FD→ Poll↓	PFCE (BT)	PFCE (AT)	GFCE (BT)	GFCE (AT)	GI (BT)	GI (AT)
1	7120267	7119612	1137149	1137014	2841669	3496361
2	8254442	1809632	732991	277453	1545209	860185
3	12604197	2708695	1137896	147766	3172711	427823
4	43512526	8610892	5459350	1089087	15299425	1699825
5	487010	41693	23918	451	63561	2128
6	253925	43409	35202	6071	73318	8813
7	9130038	257856	1260933	40685	3189413	97274
8	17317167	1129833	3357301	208297	7850649	459229
9	522194	52876	30054	12783	68049	31701
10	319783	30402	25174	1568	194611	11851
11	1406	1214	403	401	4809	3001
12	445	20	42	2	646	37
13	50097	6312	649	82	6375	184
14	31925	4911	413	64	4062	143
15	91291	37529	17324	7238	100586	59600
16	21728811	4288414	2732612	545318	7739993	868200
17	19378	8973	3307	1699	22203	14965
18	1995902	339557	234433	51766	965708	263441
19	7360	1545	391	89	1869	697
20	11686	582	4181	255	29627	1817
21	1451	734	310	147	1872	1264
22	1816	48	630	17	4689	146
23	7384	933	2003	268	3088	675
24	1187	614	254	130	1530	1054
25	75	8	40	5	53	13
26	1002702	126358	12990	1642	127678	3736
27	2381324	472249	304310	60819	889831	112052
28	567	306	113	62	828	556
29	130	75	27	16	227	147
30	10890656	2177803	1388045	277565	3912467	431937
31	319	177	64	36	503	333
32	783948	156797	103929	20787	308536	42197
33	536015	7504	2724	38	15859	1488
34	67656	27482	12817	5291	73868	43408
35	665608	132894	118548	23707	466068	120230
36	287	30	5	1	48	2

PFCE- Private Final Consumption Expenditure, GFCE-Govt. Final Consumption Expenditure, GI- Gross Investment, BT-Before Treatment values, AT- After Treatment values. For Pollutants specification, see appendix 3.2.

FD→ Poll↓	EXP (BT)	EXP (AT)	IMP (BT)	IMP (AT)	Total (BT)	Total (AT)
1	1732751	1732301	2919210	2918287	9912626	10567000
2	1159975	443746	1389188	614523	10303429	2776493
3	3644883	363906	6674725	533287	13884963	3114904
4	11724433	2312441	80874241	16167530	-4878507	-2455286
5	209545	18067	34422	2145	749612	60194
6	42222	8005	70856	12293	333811	54005
7	3547681	58058	6801204	78026	10326862	375847
8	8573710	279682	16262727	368262	20836100	1708779
9	49251	14099	90793	13079	578755	98380
10	66226	4666	167108	15876	438687	32611
11	1291	1283	7502	7500	407	-1601
12	252	11	177	8	1208	63
13	3512	442	14007	1765	46626	5255
14	2238	344	8926	1373	29713	4089
15	67601	31662	45727	18263	231075	117767
16	5772692	1152630	41229069	8299317	-3254961	-1444755
17	16382	8180	8919	4452	52351	29366
18	499319	113319	1290078	329413	2405284	438672
19	3037	692	2151	622	10507	2402
20	8933	407	18335	781	36092	2281
21	1349	689	669	346	4313	2488
22	1407	37	2912	70	5630	178
23	1894	276	2424	594	11944	1558
24	1097	570	540	281	3528	2086
25	36	5	26	9	178	23
26	70312	8879	280498	35479	933185	105137
27	634497	126711	4321277	863109	-111315	-91277
28	541	295	468	347	1581	872
29	128	75	197	171	314	142
30	2892581	578420	21018292	4203587	-1934542	-737862
31	307	173	352	286	839	432
32	215272	43061	1406328	281269	5356	-18426
33	11400	160	4492	63	561507	9127
34	49502	23034	33817	13234	170026	85981
35	236161	47222	374773	74952	1111612	249101
36	73	8	10	1	403	39

EXP- Exports, IMP-Imports, BT-Before Treatment values, AT- After Treatment values

pollutants. In the case of most of the pollutants the highest contribution in pollution generation has been from the PFCE, then followed by the GI.

PFCE has contributed most in the case of fluorides (26), organic nitrogen (13), nitrate nitrogen (14) and ammonical nitrogen (10). Then followed by the contribution for total dissolved solids (3), dissolved fixed solids (5), dissolved phosphate (36), phosphate (23), biological oxygen demand (7), chemical oxygen demand (8), oil and greases (9), chromium (19), total suspended solids (2), sulfate (18), total volatile solids (6), cadmium (29), and total acid (35). For other pollutants also PFCE contributed significantly but it was not the major contributor.

GFCE has never appeared as a major contributor for any of the pollutants. Its contribution has always remained between 0 to 25 percent. Gross investment (GI) on the other hand was next to PFCE. For cadmium (29) it has been major contributor. In the case of TKN (11), cyanide (22), phenolic compound (20), nickel (31), copper (28), lead (21), zinc (17), mercury (26), iron (15), aluminum (37), hexavalent chromium (25) and total nitrogen (12) GI has been significant contributor. For other pollutants GI has contributed below 50 percent.

Exports (EXP) have been important for cadmium (29), nickel (31), copper (28), dissolved fixed solids (5), chromium (19), zinc (17), lead (21), mercury (26), iron (15), aluminium (34) and sulfate (18). It has significant share upto 50 percent.

As is seen in the table that import has substantial share in case of most of the pollutants. In the case of cadmium (29) the highest contribution has been from import (IMP) category of final demand. In the case of sulfate (18) and nickel (31) it has dominant share. For ammonical nitrogen (10), copper (28), hexavalent chromium (25), cyanide (22), phosphate (23), phenolic compound (20), fluoride (26), organic nitrogen (13), nitrate nitrogen (14), total acid (35), and chromium (19) have also contributed significantly.

4.5 Summary

This chapter employed Indian input-output table for the year 1983-84, 1989-90 and 1993-94 to explain the pollution intensity of the different sectors of the Indian economy. The pollution intensity is defined as the total (direct plus indirect) generation of pollution per unit of output. The contribution of different sectors has been examined in total generation of pollution. The analysis has been done for both direct as well as direct-indirect water pollution intensity. In this way the differences between these two are clearly understood. The results have been examined for 'all industry' categories as well as for 'highly polluting' industrial category. This has been done by taking the pollution coefficients of highly polluting industries only and assuming as if the pollution from other sectors was zero. Apart from this pollution contribution of different categories of final demand has also been analyzed.

The analysis for direct pollution intensity has been done from three aspects– firstly, direct pollution intensity of different sectors has been analyzed. Secondly, relative share of sectors in direct pollution generation is examined and thirdly, contribution of highly polluting sectors is seen separately. The analysis showed that most of the pollution is generated by the highly polluting sectors. Other moderately or non-polluting sectors are responsible for relatively small proportion of pollution generation. Sectors such as, dairy (2), beverages (12), textile (14,17), paper (20), leather (23), rubber (24), heavy chemicals (28), fertilizers (29), drugs (32), synthetic fiber (34) etc, are the common sectors and have appeared in the case of almost all the pollutants.

The total (direct plus indirect) pollution intensity has been done from two perspectives. Firstly, interaction effect of all the sectors has been calculated by taking the direct pollution coefficients of all the sectors. Secondly, separate analysis has been done for the category of highly polluting sectors. This has been done by taking the direct pollution coefficients only and assuming pollution from other sectors to be zero. Thus, in the second analysis effect of low or moderately polluting sectors has been eliminated.

The direct plus indirect intensity has supported the results obtained from the analysis of direct pollution intensity that most of the pollution in the economy is generated by the category of highly polluting sectors. The magnitude of direct-indirect intensity has differed in the case of all sectors. The three important categories of sectors have clearly emerged from this analysis. Firstly, sectors in which there is high direct and high indirect effect. Secondly, sectors in which high direct effect but indirect effect is not very significant. Thirdly, there are sectors in which direct pollution intensity is very low but the indirect intensity component is very high. All these categories are cause of concern. The uniqueness of the input-output technique is in finding the third category.

Separate analysis done for the determination of the interaction effect of highly polluting sectors indicate that most of the pollution in the economy is generated by the highly polluting sectors. There has been very little difference found between the interaction effect of 'all sectors' and 'highly polluting' sectors. The elimination of low and moderately polluting sectors has not changed the pollution intensity significantly. Thus, maximum pollution is generated by the highly polluting industries. If it is possible to control the pollution from highly polluting sectors then, the situation can be improved upto certain extent.

Lastly, analysis has been done to determine the final demand intensity. If we divide the entire final demand components into three parts viz., consumption (private plus government), investments and exports. We find that major portion is discharged by the consumption category of the final demand in which private final consumption expenditure appear to be most dominant.

Appendix 4.1

Total (Direct Plus Indirect) Pollution Intensity, 1993-94

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0.098	0.098	0.072	0.031	0.230	0.037	1.039	0.208	0.001	2.E-05	0.001	1.E-04
2	0.351	0.351	0.345	0.051	0.724	0.357	0.385	0.077	0.002	1.E-04	5.E-04	9.E-05
3	0.081	0.081	0.078	0.015	0.066	0.011	0.373	0.075	0.001	3.E-05	4.E-04	7.E-05
4	0.023	0.023	0.012	0.006	0.024	0.003	0.688	0.137	0.002	2.E-04	0.001	1.E-04
5	2.426	2.426	0.083	0.070	0.091	0.016	1.498	0.300	0.001	5.E-05	0.001	2.E-04
6	0.410	0.410	0.018	0.013	0.032	0.004	52.243	10.449	4.E-04	2.E-05	4.E-04	8.E-05
7	0.116	0.116	0.070	0.061	0.076	0.014	1.922	0.385	0.001	3.E-05	0.001	2.E-04
8	0.124	0.124	0.035	0.028	0.054	0.007	0.859	0.172	5.E-04	2.E-05	0.001	1.E-04
9	0.117	0.117	0.079	0.034	0.246	0.029	1.179	0.236	0.001	5.E-05	0.001	2.E-04
10	0.144	0.144	0.176	0.052	0.340	0.065	1.203	0.241	0.002	1.E-04	0.002	3.E-04
11	0.178	0.178	0.123	0.038	0.260	0.073	1.406	0.281	0.003	9.E-05	0.002	4.E-04
12	0.340	0.340	11.137	0.195	6.424	0.108	1.212	0.242	0.002	7.E-05	0.002	4.E-04
13	0.149	0.149	0.092	0.031	0.128	0.022	0.878	0.175	0.002	1.E-04	0.002	3.E-04
14	0.265	0.265	0.189	0.072	0.448	0.051	1.856	0.341	0.160	0.015	0.019	0.003
15	0.246	0.246	0.160	0.064	0.380	0.043	1.712	0.319	0.124	0.012	0.020	0.003
16	0.133	0.133	0.075	0.041	0.200	0.023	1.191	0.236	0.011	0.001	0.013	0.002
17	0.653	0.653	0.138	0.085	1.096	0.148	2.544	0.483	0.013	0.001	0.234	0.039
18	0.178	0.178	0.105	0.078	0.145	0.024	1.845	0.368	0.006	0.001	0.003	5.E-04
19	0.080	0.080	0.045	0.026	0.092	0.011	0.844	0.168	0.004	1.E-04	0.005	0.001
20	1.599	1.599	1.106	0.148	0.610	0.049	1.811	0.362	0.004	2.E-04	0.004	0.001
21	0.468	0.468	0.322	0.071	0.275	0.025	1.293	0.259	0.003	2.E-04	0.003	0.001
22	0.131	0.131	0.100	0.053	0.336	0.051	1.202	0.240	0.005	4.E-04	0.006	0.001
23	0.154	0.154	0.223	0.095	1.055	0.157	1.809	0.363	0.004	2.E-04	0.005	0.001
24	0.396	0.396	0.166	0.086	0.804	0.265	2.320	0.458	0.009	0.001	0.055	0.009
25	0.419	0.419	0.226	0.081	1.206	0.097	2.752	0.539	0.236	0.001	0.111	0.019
26	0.334	0.334	0.029	0.020	0.061	0.007	38.026	7.605	0.001	3.E-05	0.001	2.E-04
27	0.810	0.810	0.087	0.062	0.153	0.019	10.994	2.199	0.002	9.E-05	0.002	4.E-04
28	0.556	0.555	0.672	0.258	8.264	0.473	3.314	0.662	0.005	1.E-04	0.007	0.001
29	0.906	0.906	0.631	0.156	3.292	0.349	8.589	1.718	0.006	1.E-04	0.004	0.001
30	0.336	0.336	0.277	0.133	1.576	0.108	2.479	0.496	0.006	2.E-04	0.005	0.001
31	0.306	0.306	0.288	0.146	1.892	0.128	2.952	0.605	0.006	2.E-04	0.026	0.012
32	2.364	2.363	1.740	0.208	0.962	0.064	1.942	0.388	0.007	3.E-04	0.005	0.001
33	0.305	0.305	0.219	0.109	1.135	0.091	2.174	0.443	0.007	4.E-04	0.007	0.001
34	0.957	0.957	0.197	0.093	2.093	0.236	5.064	0.978	0.005	2.E-04	0.344	0.057
35	0.295	0.295	0.074	0.050	0.198	0.019	2.054	0.411	0.002	7.E-05	0.002	3.E-04
36	0.501	0.501	0.145	0.123	0.141	0.025	1.990	0.397	0.012	3.E-04	0.006	0.001
37	0.248	0.247	0.108	0.066	0.393	0.031	2.842	0.568	0.003	1.E-04	0.003	5.E-04
38	0.483	0.483	0.110	0.084	0.212	0.037	2.469	0.494	0.002	9.E-05	0.002	3.E-04
39	0.304	0.304	0.146	0.119	0.257	0.031	2.281	0.456	0.003	2.E-04	0.002	4.E-04
40	0.260	0.260	0.101	0.076	0.202	0.030	1.882	0.376	0.003	1.E-04	0.003	0.001
41	0.221	0.221	0.099	0.074	0.190	0.029	1.930	0.385	0.003	2.E-04	0.004	0.001
42	0.202	0.202	0.098	0.070	0.194	0.025	1.883	0.376	0.003	2.E-04	0.004	0.001
43	0.209	0.209	0.090	0.066	0.199	0.025	1.696	0.339	0.004	1.E-04	0.004	0.001
44	0.207	0.207	0.100	0.065	0.280	0.030	1.725	0.344	0.010	2.E-04	0.013	0.002
45	0.238	0.238	0.139	0.076	0.767	0.057	2.196	0.437	0.014	3.E-04	0.017	0.003
46	0.160	0.160	0.100	0.054	0.393	0.032	1.114	0.224	0.002	1.E-04	0.004	0.001
47	0.197	0.197	0.080	0.059	0.241	0.026	1.365	0.272	0.002	7.E-05	0.007	0.001
48	0.213	0.213	0.107	0.080	0.204	0.036	1.649	0.329	0.002	1.E-04	0.008	0.001
49	0.261	0.261	0.113	0.070	0.305	0.097	1.813	0.362	0.005	2.E-04	0.006	0.001
50	0.501	0.501	0.139	0.097	0.230	0.054	1.663	0.332	0.004	2.E-04	0.002	4.E-04
51	0.199	0.199	0.116	0.072	0.455	0.038	1.834	0.366	0.007	2.E-04	0.007	0.001
52	0.169	0.169	0.065	0.047	0.120	0.016	1.387	0.277	0.002	7.E-05	0.003	0.001
53	0.998	0.998	0.816	0.801	0.163	0.103	5.449	1.090	0.001	6.E-05	0.003	4.E-04
54	0.088	0.088	0.061	0.052	0.054	0.010	0.729	0.146	0.001	2.E-05	0.001	1.E-04
55	0.167	0.167	0.088	0.067	0.100	0.021	4.293	0.858	0.004	1.E-04	0.004	0.001
56	0.086	0.086	0.062	0.022	0.074	0.009	0.493	0.098	0.001	8.E-05	0.002	3.E-04

BT- Before Abatement Values, AT- After Abatement Values. For sectors and pollutants specification, see appendices 3.1 and 3.2

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0.123	0.003	0.285	0.010	0.019	0.001	0.014	0.002	5.E-05	5.E-05	3.E-06	2.E-07
2	0.247	0.013	0.645	0.074	0.041	0.002	0.004	4.E-04	2.E-05	2.E-05	2.E-06	1.E-07
3	0.156	0.005	0.290	0.012	0.005	4.E-04	0.003	4.E-04	2.E-05	2.E-05	2.E-06	1.E-07
4	0.023	5.E-04	0.056	0.003	3.E-04	1.E-04	0.001	6.E-05	2.E-05	2.E-05	4.E-06	2.E-07
5	0.088	0.001	0.219	0.012	0.002	0.001	0.003	2.E-04	2.E-04	2.E-04	1.E-05	5.E-07
6	0.033	5.E-04	0.081	0.003	4.E-04	2.E-04	0.001	8.E-05	3.E-05	3.E-05	2.E-06	8.E-08
7	0.075	0.001	0.186	0.013	0.001	0.001	0.002	0.001	0.001	0.001	2.E-05	7.E-07
8	0.058	0.003	0.155	0.025	0.001	0.001	0.005	0.004	0.008	0.008	8.E-06	4.E-07
9	0.176	0.003	0.442	0.015	0.011	0.001	0.008	0.001	2.E-04	7.E-05	5.E-06	2.E-07
10	0.291	0.005	0.687	0.022	0.045	0.001	0.009	0.001	4.E-05	4.E-05	7.E-06	3.E-07
11	0.195	0.005	0.450	0.025	0.013	0.001	0.005	0.001	5.E-05	4.E-05	1.E-05	5.E-07
12	7.195	0.101	0.450	0.023	0.004	0.001	0.175	0.003	1.E-04	1.E-04	1.E-05	5.E-07
13	0.125	0.003	0.328	0.029	0.004	0.001	0.003	3.E-04	3.E-05	3.E-05	7.E-06	3.E-07
14	0.246	0.009	0.579	0.048	0.006	0.002	0.004	4.E-04	4.E-05	4.E-05	1.E-05	6.E-07
15	0.234	0.008	0.552	0.043	0.003	0.002	0.002	2.E-04	4.E-05	4.E-05	1.E-05	5.E-07
16	0.188	0.005	0.446	0.020	0.002	0.001	0.003	2.E-04	4.E-05	4.E-05	8.E-06	4.E-07
17	0.721	0.050	1.791	0.146	0.003	0.001	0.002	2.E-04	5.E-05	5.E-05	1.E-05	5.E-07
18	0.116	0.002	0.284	0.016	0.006	0.001	0.005	5.E-04	5.E-05	5.E-05	2.E-05	7.E-07
19	0.086	0.002	0.214	0.012	0.001	5.E-04	0.001	1.E-04	1.E-04	1.E-04	8.E-06	4.E-07
20	1.008	0.036	2.926	0.433	0.003	0.002	0.003	3.E-04	8.E-05	8.E-05	1.E-05	6.E-07
21	0.376	0.011	1.032	0.117	0.002	0.001	0.002	2.E-04	5.E-05	5.E-05	1.E-05	5.E-07
22	0.259	0.005	0.619	0.023	0.002	0.001	0.002	2.E-04	4.E-05	4.E-05	1.E-04	5.E-06
23	0.543	0.012	1.301	0.039	0.003	0.001	0.002	2.E-04	4.E-05	4.E-05	1.E-05	7.E-07
24	0.716	0.020	1.661	0.077	0.004	0.001	0.005	4.E-04	6.E-05	6.E-05	0.002	1.E-04
25	0.750	0.027	1.830	0.087	0.003	0.001	0.002	2.E-04	5.E-05	5.E-05	2.E-05	8.E-07
26	0.108	0.001	0.223	0.007	0.001	0.001	0.007	0.001	3.E-05	3.E-05	4.E-06	2.E-07
27	0.158	0.003	0.385	0.015	0.002	0.001	0.004	0.002	1.E-04	1.E-04	2.E-05	7.E-07
28	8.966	0.052	21.252	0.165	0.010	0.003	0.007	0.001	2.E-04	2.E-04	1.E-05	5.E-07
29	1.624	0.032	3.650	0.064	0.314	0.008	0.247	0.031	0.001	0.001	1.E-05	5.E-07
30	1.653	0.015	3.960	0.064	0.015	0.003	0.011	0.001	1.E-04	1.E-04	1.E-05	5.E-07
31	2.035	0.020	4.886	0.098	0.006	0.003	0.003	3.E-04	1.E-04	1.E-04	1.E-05	5.E-07
32	2.055	0.135	6.764	0.615	0.103	0.051	0.002	2.E-04	7.E-05	7.E-05	1.E-05	7.E-07
33	1.185	0.010	2.842	0.053	0.006	0.002	0.005	0.001	9.E-05	9.E-05	1.E-05	5.E-07
34	1.614	0.076	3.946	0.222	0.004	0.001	0.003	3.E-04	8.E-05	8.E-05	1.E-05	5.E-07
35	0.209	0.003	0.509	0.019	0.002	0.001	0.003	0.001	0.002	0.002	1.E-05	5.E-07
36	0.114	0.003	0.290	0.027	0.003	0.002	0.004	0.002	0.003	0.003	1.E-05	7.E-07
37	0.418	0.004	1.002	0.021	0.002	0.001	0.003	0.001	0.001	0.001	1.E-05	5.E-07
38	0.221	0.005	0.512	0.022	0.002	0.001	0.094	0.004	2.E-04	2.E-04	1.E-05	6.E-07
39	0.261	0.003	0.633	0.022	0.003	0.002	0.010	0.001	3.E-04	3.E-04	1.E-05	5.E-07
40	0.200	0.003	0.481	0.019	0.002	0.001	0.025	0.001	2.E-04	2.E-04	1.E-05	6.E-07
41	0.189	0.003	0.456	0.019	0.002	0.001	0.018	0.001	8.E-05	8.E-05	6.E-05	3.E-06
42	0.195	0.003	0.474	0.019	0.002	0.001	0.016	0.001	8.E-05	8.E-05	2.E-05	8.E-07
43	0.201	0.003	0.484	0.017	0.002	0.001	0.021	0.001	8.E-05	8.E-05	2.E-05	7.E-07
44	0.263	0.005	0.639	0.025	0.002	0.001	0.012	0.001	1.E-04	1.E-04	1.E-05	5.E-07
45	0.782	0.009	1.873	0.037	0.002	0.001	0.007	4.E-04	1.E-04	1.E-04	1.E-05	6.E-07
46	0.422	0.005	1.020	0.025	0.002	0.001	0.011	5.E-04	6.E-05	6.E-05	7.E-06	3.E-07
47	0.242	0.004	0.579	0.017	0.002	0.001	0.020	0.001	7.E-05	7.E-05	9.E-06	4.E-07
48	0.195	0.004	0.474	0.022	0.002	0.001	0.014	0.001	8.E-05	8.E-05	8.E-05	4.E-06
49	0.243	0.005	0.594	0.032	0.002	0.001	0.012	0.001	7.E-05	7.E-05	7.E-05	3.E-06
50	0.228	0.019	0.549	0.066	0.002	0.001	0.010	5.E-04	6.E-05	6.E-05	1.E-05	5.E-07
51	0.469	0.005	1.126	0.027	0.002	0.001	0.009	0.001	5.E-04	5.E-04	1.E-05	6.E-07
52	0.117	0.002	0.286	0.014	0.002	0.001	0.011	0.001	0.001	0.001	1.E-05	5.E-07
53	0.070	0.002	0.242	0.078	0.013	0.012	0.002	2.E-04	6.E-05	6.E-05	1.E-05	5.E-07
54	0.055	0.001	0.133	0.008	0.001	0.001	0.002	1.E-04	9.E-05	9.E-05	3.E-06	1.E-07
55	0.092	0.002	0.226	0.016	0.002	0.001	0.003	3.E-04	0.000	9.E-05	6.E-05	3.E-06
56	0.086	0.003	0.226	0.016	0.003	0.001	0.002	1.E-04	3.E-05	3.E-05	4.E-06	2.E-07

Poll.→ Sec.↓	13 BT	13 AT	14 BT	14 AT	15 BT	15 AT	16 BT	16 AT	17 BT	17 AT	18 BT	18 AT
1	0.003	4.E-04	0.002	3.E-04	0.001	2.E-04	0.533	0.107	2.E-04	6.E-05	0.049	0.008
1	0.003	4.E-04	0.002	3.E-04	0.001	2.E-04	0.533	0.107	2.E-04	6.E-05	0.049	0.008
2	0.001	1.E-04	0.001	8.E-05	3.E-04	1.E-04	0.196	0.039	9.E-05	3.E-05	0.015	0.003
3	0.001	1.E-04	5.E-04	8.E-05	3.E-04	1.E-04	0.191	0.038	9.E-05	3.E-05	0.015	0.003
4	3.E-05	3.E-06	2.E-05	3.E-06	0.001	4.E-04	0.349	0.070	2.E-04	1.E-04	0.009	0.002
5	6.E-05	7.E-06	4.E-05	6.E-06	0.052	0.011	0.764	0.154	2.E-04	1.E-04	1.762	0.354
6	2.E-05	3.E-06	1.E-05	2.E-06	0.001	2.E-04	26.705	5.341	1.E-04	5.E-05	0.310	0.062
7	5.E-05	6.E-06	3.E-05	5.E-06	0.001	4.E-04	0.990	0.208	2.E-04	1.E-04	0.050	0.020
8	4.E-05	5.E-06	3.E-05	4.E-06	0.001	5.E-04	0.518	0.168	0.001	5.E-04	0.097	0.084
9	0.002	2.E-04	0.001	2.E-04	0.001	3.E-04	0.603	0.121	2.E-04	7.E-05	0.044	0.008
10	0.002	3.E-04	0.001	2.E-04	0.002	0.001	0.613	0.123	3.E-04	1.E-04	0.056	0.010
11	0.001	1.E-04	0.001	1.E-04	0.001	5.E-04	0.716	0.143	2.E-04	1.E-04	0.044	0.008
12	5.E-04	6.E-05	3.E-04	5.E-05	0.002	0.001	1.360	0.134	3.E-04	1.E-04	0.831	0.023
13	5.E-04	6.E-05	3.E-04	5.E-05	0.001	5.E-04	0.446	0.089	0.000	1.E-04	0.033	0.007
14	0.001	9.E-05	5.E-04	7.E-05	0.007	0.004	0.816	0.159	0.002	0.001	0.052	0.010
15	3.E-04	4.E-05	2.E-04	3.E-05	0.009	0.004	0.763	0.150	0.002	0.001	0.054	0.011
16	2.E-04	3.E-05	1.E-04	2.E-05	0.004	0.002	0.583	0.116	0.001	4.E-04	0.037	0.008
17	3.E-04	4.E-05	2.E-04	3.E-05	0.008	0.004	0.925	0.185	0.002	0.001	0.067	0.014
18	0.001	9.E-05	5.E-04	7.E-05	0.002	0.001	0.936	0.187	3.E-04	2.E-04	0.066	0.013
19	5.E-05	7.E-06	3.E-05	5.E-06	0.002	0.001	0.424	0.086	0.001	3.E-04	0.024	0.006
20	3.E-04	3.E-05	2.E-04	3.E-05	0.008	0.003	0.918	0.184	0.001	5.E-04	0.179	0.036
21	1.E-04	2.E-05	8.E-05	1.E-05	0.015	0.007	0.655	0.131	0.004	0.002	0.069	0.015
22	2.E-04	3.E-05	1.E-04	2.E-05	0.009	0.004	0.574	0.115	0.002	0.001	0.033	0.007
23	2.E-04	3.E-05	1.E-04	2.E-05	0.014	0.007	0.731	0.147	0.004	0.002	0.034	0.007
24	0.001	6.E-05	3.E-04	5.E-05	0.006	0.003	1.093	0.219	0.001	0.001	0.073	0.015
25	2.E-04	3.E-05	1.E-04	2.E-05	0.008	0.004	1.368	0.247	0.002	0.001	0.067	0.014
26	5.E-05	6.E-06	3.E-05	4.E-06	0.001	0.001	19.377	3.875	2.E-04	1.E-04	0.232	0.047
27	1.E-04	1.E-05	7.E-05	1.E-05	0.015	0.003	5.615	1.124	3.E-04	2.E-04	0.534	0.108
28	0.001	2.E-04	8.E-04	1.E-04	0.005	0.002	1.686	0.338	0.001	3.E-04	0.145	0.030
29	0.063	0.008	0.040	0.006	0.003	0.001	4.437	0.888	0.003	0.001	0.682	0.101
30	0.002	3.E-04	0.001	2.E-04	0.004	0.001	1.330	0.254	0.001	3.E-04	0.107	0.022
31	4.E-04	5.E-05	2.E-04	4.E-05	0.429	0.223	1.478	0.296	0.118	0.061	0.099	0.021
32	3.E-04	3.E-05	2.E-04	3.E-05	0.003	0.001	0.985	0.197	4.E-04	2.E-04	0.060	0.013
33	0.001	1.E-04	5.E-04	8.E-05	0.006	0.002	1.091	0.218	0.001	0.001	0.098	0.019
34	4.E-04	5.E-05	3.E-04	4.E-05	0.011	0.005	2.049	0.410	0.002	0.001	0.106	0.022
35	9.E-05	1.E-05	6.E-05	9.E-06	0.007	0.002	1.061	0.224	0.001	5.E-04	0.178	0.048
36	9.E-05	1.E-05	6.E-05	9.E-06	0.009	0.002	1.021	0.212	3.E-04	2.E-04	0.279	0.065
37	1.E-04	1.E-05	7.E-05	1.E-05	0.004	0.001	1.456	0.300	0.001	3.E-04	0.114	0.032
38	7.E-05	9.E-06	5.E-05	7.E-06	0.007	0.002	1.262	0.253	0.000	2.E-04	0.214	0.046
39	9.E-05	1.E-05	6.E-05	9.E-06	0.005	0.001	1.164	0.235	0.000	3.E-04	0.177	0.078
40	8.E-05	1.E-05	5.E-05	8.E-06	0.006	0.002	0.959	0.193	0.001	4.E-04	0.116	0.030
41	8.E-05	1.E-05	5.E-05	8.E-06	0.005	0.002	0.979	0.196	0.001	5.E-04	0.089	0.020
42	9.E-05	1.E-05	5.E-05	8.E-06	0.004	0.002	0.955	0.191	0.001	3.E-04	0.077	0.018
43	8.E-05	9.E-06	5.E-05	7.E-06	0.005	0.002	0.861	0.172	0.001	4.E-04	0.083	0.019
44	1.E-04	1.E-05	6.E-05	9.E-06	0.005	0.002	0.865	0.172	0.001	5.E-04	0.074	0.021
45	2.E-04	2.E-05	1.E-04	2.E-05	0.004	0.001	1.101	0.220	0.001	3.E-04	0.082	0.026
46	1.E-04	2.E-05	8.E-05	1.E-05	0.038	0.019	0.563	0.113	0.010	0.005	0.052	0.011
47	7.E-05	9.E-06	4.E-05	7.E-06	0.006	0.003	0.687	0.138	0.001	0.001	0.078	0.017
48	9.E-05	1.E-05	6.E-05	9.E-06	0.006	0.003	0.831	0.166	0.001	0.001	0.074	0.017
49	1.E-04	1.E-05	6.E-05	9.E-06	0.006	0.002	0.918	0.183	0.001	0.001	0.064	0.014
50	8.E-05	1.E-05	5.E-05	8.E-06	0.003	0.001	0.846	0.169	0.001	3.E-04	0.063	0.015
51	1.E-04	2.E-05	9.E-05	1.E-05	0.004	0.002	0.928	0.186	0.001	4.E-04	0.071	0.020
52	2.E-04	2.E-05	1.E-04	2.E-05	0.010	0.005	0.710	0.146	0.002	0.001	0.079	0.021
53	6.E-05	7.E-06	4.E-05	6.E-06	0.009	0.002	2.781	0.556	2.E-04	1.E-04	0.321	0.065
54	6.E-05	8.E-06	4.E-05	6.E-06	0.002	0.001	0.372	0.075	5.E-04	2.E-04	0.031	0.007
55	1.E-04	2.E-05	9.E-05	1.E-05	0.002	0.001	2.184	0.437	3.E-04	2.E-04	0.067	0.014
56	1.E-04	1.E-05	7.E-05	1.E-05	0.001	4.E-04	0.250	0.050	2.E-04	9.E-05	0.018	0.004

Poll.→ Sec.↓	19 BT	19 AT	20 BT	20 AT	21 BT	21 AT	22 BT	22 AT	23 BT	23 AT	24 BT	24 AT
1	3.E-04	7.E-05	7.E-05	3.E-06	6.E-06	3.E-06	1.E-05	3.E-07	3.E-04	4.E-05	5.E-06	3.E-06
2	7.E-05	2.E-05	4.E-05	3.E-06	5.E-06	2.E-06	6.E-06	2.E-07	9.E-05	1.E-05	4.E-06	2.E-06
3	6.E-05	2.E-05	5.E-05	4.E-06	5.E-06	2.E-06	7.E-06	3.E-07	1.E-04	1.E-05	4.E-06	2.E-06
4	2.E-05	6.E-06	9.E-05	4.E-06	2.E-05	1.E-05	2.E-05	4.E-07	1.E-05	2.E-06	2.E-05	8.E-06
5	9.E-05	9.E-06	4.E-04	2.E-05	2.E-05	8.E-06	6.E-05	2.E-06	4.E-05	1.E-05	1.E-05	7.E-06
6	3.E-05	3.E-06	2.E-04	8.E-06	9.E-06	4.E-06	3.E-05	6.E-07	1.E-05	3.E-06	7.E-06	4.E-06
7	1.E-04	3.E-05	2.E-04	2.E-05	1.E-05	7.E-06	3.E-05	3.E-06	9.E-05	6.E-05	9.E-06	5.E-06
8	2.E-04	2.E-04	2.E-04	9.E-05	2.E-05	1.E-05	3.E-05	2.E-05	4.E-04	4.E-04	8.E-06	4.E-06
9	1.E-04	4.E-05	1.E-04	7.E-06	1.E-05	5.E-06	2.E-05	6.E-07	2.E-04	3.E-05	8.E-06	4.E-06
10	2.E-04	5.E-05	1.E-04	7.E-06	2.E-05	9.E-06	2.E-05	6.E-07	2.E-04	3.E-05	1.E-05	8.E-06
11	1.E-04	3.E-05	1.E-04	8.E-06	2.E-05	8.E-06	2.E-05	6.E-07	2.E-04	2.E-05	1.E-05	6.E-06
12	1.E-04	2.E-05	3.E-04	1.E-05	2.E-05	1.E-05	4.E-05	1.E-06	9.E-05	1.E-05	2.E-05	9.E-06
13	8.E-05	1.E-05	2.E-04	1.E-05	2.E-05	8.E-06	4.E-05	9.E-07	9.E-05	1.E-05	1.E-05	7.E-06
14	0.001	9.E-05	2.E-04	1.E-05	1.E-04	8.E-05	3.E-05	2.E-06	1.E-04	1.E-05	1.E-04	6.E-05
15	5.E-04	8.E-05	2.E-04	1.E-05	2.E-04	1.E-04	3.E-05	2.E-06	7.E-05	1.E-05	1.E-04	8.E-05
16	1.E-04	3.E-05	3.E-04	1.E-05	7.E-05	4.E-05	4.E-05	1.E-06	6.E-05	8.E-06	6.E-05	3.E-05
17	2.E-04	5.E-05	2.E-04	1.E-05	2.E-04	8.E-05	3.E-05	2.E-06	8.E-05	1.E-05	1.E-04	7.E-05
18	1.E-04	2.E-05	3.E-04	1.E-05	3.E-05	1.E-05	5.E-05	1.E-06	1.E-04	1.E-05	2.E-05	1.E-05
19	5.E-05	2.E-05	2.E-04	9.E-06	4.E-05	2.E-05	3.E-05	1.E-06	3.E-05	9.E-06	3.E-05	2.E-05
20	1.E-04	3.E-05	3.E-04	1.E-05	8.E-05	4.E-05	4.E-05	1.E-06	7.E-05	1.E-05	7.E-05	3.E-05
21	2.E-04	8.E-05	2.E-04	1.E-05	3.E-04	2.E-04	4.E-05	3.E-06	5.E-05	8.E-06	2.E-04	1.E-04
22	0.001	2.E-04	2.E-04	1.E-05	2.E-04	1.E-04	3.E-05	2.E-06	7.E-05	1.E-05	2.E-04	8.E-05
23	0.006	1.E-03	2.E-04	1.E-05	3.E-04	2.E-04	3.E-05	3.E-06	8.E-05	1.E-05	3.E-04	1.E-04
24	3.E-04	5.E-05	3.E-04	1.E-05	1.E-04	6.E-05	5.E-05	2.E-06	9.E-05	1.E-05	9.E-05	5.E-05
25	0.000	4.E-05	2.E-04	1.E-05	1.E-04	8.E-05	4.E-05	2.E-06	6.E-05	9.E-06	1.E-04	6.E-05
26	6.E-05	7.E-06	2.E-04	8.E-06	2.E-05	1.E-05	3.E-05	7.E-07	2.E-04	8.E-06	2.E-05	9.E-06
27	1.E-04	1.E-05	5.E-04	2.E-04	3.E-05	1.E-05	6.E-05	7.E-06	7.E-05	1.E-05	2.E-05	1.E-05
28	2.E-04	4.E-05	3.E-04	2.E-05	5.E-05	2.E-05	5.E-05	2.E-06	2.E-04	4.E-05	4.E-05	2.E-05
29	0.005	0.001	3.E-04	2.E-05	3.E-05	1.E-05	4.E-05	2.E-06	0.005	0.001	2.E-05	1.E-05
30	4.E-04	6.E-05	4.E-04	2.E-05	5.E-05	3.E-05	6.E-05	2.E-06	4.E-04	5.E-05	4.E-05	2.E-05
31	0.005	0.003	3.E-04	2.E-05	0.010	0.005	2.E-04	7.E-05	1.E-04	2.E-05	0.008	0.004
32	1.E-04	1.E-05	0.003	0.001	2.E-04	4.E-05	2.E-04	3.E-05	0.011	0.001	2.E-04	9.E-05
33	0.002	4.E-05	0.000	1.E-05	9.E-05	4.E-05	4.E-05	2.E-06	0.000	2.E-05	7.E-05	4.E-05
34	0.000	6.E-05	0.000	1.E-05	2.E-04	1.E-04	4.E-05	2.E-06	0.000	1.E-05	2.E-04	9.E-05
35	0.000	5.E-05	0.000	3.E-05	6.E-05	3.E-05	4.E-05	4.E-06	0.000	8.E-05	5.E-05	3.E-05
36	0.000	3.E-05	0.000	3.E-05	2.E-05	1.E-05	6.E-05	3.E-06	0.000	6.E-05	2.E-05	9.E-06
37	9.E-05	3.E-05	3.E-04	2.E-05	5.E-05	2.E-05	5.E-05	3.E-06	1.E-04	6.E-05	3.E-05	2.E-05
38	5.E-05	1.E-05	0.017	0.001	3.E-05	1.E-05	0.003	5.E-05	7.E-05	2.E-05	2.E-05	1.E-05
39	9.E-05	2.E-05	0.002	7.E-05	4.E-05	2.E-05	3.E-04	6.E-06	6.E-05	2.E-05	3.E-05	2.E-05
40	8.E-05	2.E-05	0.004	2.E-04	7.E-05	4.E-05	0.001	1.E-05	6.E-05	2.E-05	6.E-05	3.E-05
41	8.E-05	2.E-05	0.003	1.E-04	7.E-05	4.E-05	0.001	9.E-06	6.E-05	1.E-05	6.E-05	3.E-05
42	7.E-05	2.E-05	0.003	1.E-04	5.E-05	3.E-05	5.E-04	8.E-06	7.E-05	1.E-05	4.E-05	2.E-05
43	7.E-05	2.E-05	0.004	1.E-04	6.E-05	3.E-05	0.001	1.E-05	6.E-05	1.E-05	5.E-05	3.E-05
44	0.000	2.E-05	0.002	8.E-05	7.E-05	4.E-05	3.E-04	6.E-06	6.E-05	1.E-05	6.E-05	3.E-05
45	9.E-05	2.E-05	0.001	4.E-05	5.E-05	2.E-05	2.E-04	3.E-06	6.E-05	1.E-05	4.E-05	2.E-05
46	5.E-04	2.E-04	0.002	7.E-05	0.001	4.E-04	3.E-04	1.E-05	9.E-05	1.E-05	7.E-04	4.E-04
47	8.E-05	3.E-05	0.004	1.E-04	1.E-04	5.E-05	0.001	1.E-05	4.E-05	7.E-06	8.E-05	4.E-05
48	1.E-04	3.E-05	0.002	9.E-05	1.E-04	6.E-05	4.E-04	7.E-06	6.E-05	1.E-05	9.E-05	5.E-05
49	1.E-04	3.E-05	0.002	8.E-05	9.E-05	5.E-05	3.E-04	7.E-06	6.E-05	1.E-05	8.E-05	4.E-05
50	6.E-05	1.E-05	0.002	7.E-05	4.E-05	2.E-05	3.E-04	5.E-06	6.E-05	9.E-06	4.E-05	2.E-05
51	1.E-04	3.E-05	0.001	6.E-05	7.E-05	3.E-05	2.E-04	5.E-06	6.E-05	2.E-05	6.E-05	3.E-05
52	1.E-04	6.E-05	0.002	7.E-05	2.E-04	1.E-04	3.E-04	7.E-06	8.E-05	3.E-05	2.E-04	8.E-05
53	5.E-05	7.E-06	3.E-04	1.E-05	2.E-05	8.E-06	5.E-05	1.E-06	4.E-05	7.E-06	1.E-05	7.E-06
54	4.E-05	1.E-05	3.E-04	1.E-05	4.E-05	2.E-05	4.E-05	1.E-06	3.E-05	6.E-06	3.E-05	2.E-05
55	5.E-05	1.E-05	3.E-04	1.E-05	3.E-05	1.E-05	5.E-05	1.E-06	7.E-05	8.E-06	2.E-05	1.E-05
56	3.E-05	7.E-06	2.E-04	2.E-05	2.E-05	8.E-06	3.E-05	1.E-06	2.E-04	2.E-05	1.E-05	8.E-06

Poll.→	25		26		27		28		29		30	
Sec.↓	**BT**	**AT**	**BT**	**AT**	**BT**	**AT**	**BT**	**AT**	**BT**	**AT**	**BT**	**AT**
1	4.E-07	8.E-08	0.068	0.009	0.060	0.012	3.E-06	2.E-06	1.E-06	1.E-06	0.271	0.054
2	4.E-07	6.E-08	0.017	0.002	0.022	0.004	2.E-06	1.E-06	6.E-07	5.E-07	0.099	0.020
3	8.E-07	1.E-07	0.016	0.002	0.021	0.004	2.E-06	1.E-06	6.E-07	4.E-07	0.097	0.019
4	2.E-07	3.E-08	0.001	6.E-05	0.036	0.007	8.E-06	4.E-06	2.E-06	1.E-06	0.178	0.036
5	1.E-06	3.E-07	0.001	2.E-04	0.301	0.060	1.E-05	9.E-06	5.E-06	4.E-06	0.389	0.078
6	5.E-07	5.E-08	4.E-04	6.E-05	2.748	0.549	4.E-06	2.E-06	1.E-06	8.E-07	13.648	2.730
7	2.E-06	1.E-06	0.001	1.E-04	0.104	0.021	4.E-05	4.E-05	2.E-05	2.E-05	0.500	0.100
8	9.E-06	8.E-06	0.001	3.E-04	0.046	0.009	2.E-04	2.E-04	2.E-04	2.E-04	0.223	0.045
9	9.E-07	1.E-07	0.037	0.005	0.066	0.013	5.E-06	3.E-06	2.E-06	1.E-06	0.307	0.061
10	1.E-06	1.E-07	0.040	0.005	0.069	0.014	8.E-06	5.E-06	2.E-06	2.E-06	0.312	0.062
11	1.E-06	2.E-07	0.023	0.003	0.078	0.015	7.E-06	4.E-06	2.E-06	1.E-06	0.364	0.073
12	2.E-06	2.E-07	0.010	0.001	0.070	0.014	1.E-05	7.E-06	3.E-06	3.E-06	0.314	0.063
13	1.E-06	2.E-07	0.010	0.001	0.049	0.010	7.E-06	4.E-06	2.E-06	1.E-06	0.227	0.045
14	1.E-06	1.E-07	0.014	0.002	0.085	0.017	6.E-05	3.E-05	1.E-05	7.E-06	0.396	0.079
15	1.E-06	1.E-07	0.006	0.001	0.081	0.016	7.E-05	4.E-05	2.E-05	8.E-06	0.374	0.075
16	1.E-06	1.E-07	0.005	0.001	0.063	0.013	3.E-05	1.E-05	6.E-06	3.E-06	0.296	0.059
17	1.E-06	2.E-07	0.006	0.001	0.102	0.020	6.E-05	3.E-05	1.E-05	8.E-06	0.470	0.094
18	1.E-06	1.E-07	0.014	0.002	0.103	0.021	1.E-05	6.E-06	3.E-06	2.E-06	0.476	0.095
19	7.E-07	2.E-07	0.001	1.E-04	0.046	0.009	0.000	1.E-05	0.000	4.E-06	0.216	0.043
20	2.E-06	2.E-07	0.005	0.001	0.115	0.023	3.E-05	2.E-05	8.E-06	5.E-06	0.468	0.094
21	1.E-06	1.E-07	0.003	3.E-04	0.075	0.015	1.E-04	6.E-05	3.E-05	1.E-05	0.334	0.067
22	2.E-06	2.E-07	0.004	0.001	0.059	0.012	7.E-05	4.E-05	2.E-05	9.E-06	0.277	0.055
23	1.E-06	2.E-07	0.005	0.001	0.058	0.012	1.E-04	7.E-05	3.E-05	1.E-05	0.273	0.055
24	3.E-06	2.E-07	0.010	0.001	0.120	0.024	5.E-05	2.E-05	1.E-05	6.E-06	0.557	0.111
25	2.E-06	1.E-07	0.004	0.001	0.133	0.027	6.E-05	3.E-05	1.E-05	7.E-06	0.628	0.126
26	9.E-07	8.E-08	0.001	1.E-04	1.994	0.399	9.E-06	5.E-06	2.E-06	1.E-06	9.903	1.981
27	2.E-06	2.E-07	0.002	3.E-04	0.637	0.127	1.E-05	8.E-06	4.E-06	3.E-06	2.869	0.574
28	3.E-06	5.E-07	0.026	0.003	0.188	0.038	2.E-05	2.E-05	8.E-06	6.E-06	0.859	0.172
29	3.E-06	8.E-07	1.261	0.159	0.528	0.101	3.E-05	2.E-05	1.E-05	1.E-05	2.239	0.448
30	6.E-06	6.E-07	0.045	0.006	0.140	0.028	2.E-05	1.E-05	6.E-06	4.E-06	0.654	0.132
31	3.E-06	3.E-07	0.008	0.001	0.165	0.034	0.004	0.002	0.001	4.E-04	0.754	0.151
32	2.E-04	3.E-05	0.005	0.001	0.107	0.021	1.E-05	8.E-06	4.E-06	2.E-06	0.502	0.100
33	2.E-05	5.E-07	0.016	0.002	0.123	0.024	4.E-05	2.E-05	9.E-06	5.E-06	0.558	0.111
34	2.E-06	2.E-07	0.008	0.001	0.221	0.044	8.E-05	4.E-05	2.E-05	1.E-05	1.045	0.209
35	3.E-06	2.E-06	0.002	3.E-04	0.127	0.025	7.E-05	6.E-05	4.E-05	3.E-05	0.534	0.107
36	2.E-06	1.E-06	0.002	3.E-04	0.136	0.027	4.E-05	4.E-05	2.E-05	2.E-05	0.513	0.103
37	2.E-06	1.E-06	0.002	3.E-04	0.159	0.032	5.E-05	4.E-05	3.E-05	2.E-05	0.738	0.148
38	1.E-06	3.E-07	0.001	2.E-04	0.154	0.031	2.E-05	1.E-05	6.E-06	5.E-06	0.642	0.128
39	2.E-06	4.E-07	0.002	3.E-04	0.133	0.027	2.E-05	2.E-05	9.E-06	7.E-06	0.592	0.118
40	1.E-06	3.E-07	0.002	2.E-04	0.111	0.022	3.E-05	2.E-05	9.E-06	7.E-06	0.488	0.098
41	1.E-06	2.E-07	0.002	2.E-04	0.110	0.022	3.E-05	2.E-05	8.E-06	5.E-06	0.499	0.100
42	1.E-06	2.E-07	0.002	2.E-04	0.106	0.021	2.E-05	1.E-05	6.E-06	4.E-06	0.487	0.097
43	1.E-06	2.E-07	0.002	2.E-04	0.097	0.019	3.E-05	1.E-05	6.E-06	4.E-06	0.438	0.088
44	1.E-06	2.E-07	0.002	2.E-04	0.095	0.019	3.E-05	2.E-05	8.E-06	5.E-06	0.438	0.088
45	1.E-06	2.E-07	0.003	4.E-04	0.120	0.024	2.E-05	1.E-05	6.E-06	4.E-06	0.558	0.112
46	2.E-06	3.E-07	0.002	3.E-04	0.064	0.013	3.E-04	2.E-04	7.E-05	4.E-05	0.287	0.057
47	8.E-07	1.E-07	0.001	2.E-04	0.079	0.016	4.E-05	2.E-05	9.E-06	5.E-06	0.350	0.070
48	1.E-06	2.E-07	0.002	2.E-04	0.093	0.019	4.E-05	2.E-05	1.E-05	6.E-06	0.423	0.085
49	1.E-06	2.E-07	0.002	2.E-04	0.101	0.020	4.E-05	2.E-05	9.E-06	5.E-06	0.467	0.093
50	1.E-06	2.E-07	0.002	2.E-04	0.093	0.019	2.E-05	1.E-05	5.E-06	3.E-06	0.431	0.086
51	2.E-06	3.E-07	0.003	4.E-04	0.102	0.020	3.E-05	2.E-05	9.E-06	7.E-06	0.471	0.094
52	1.E-06	6.E-07	0.003	4.E-04	0.081	0.016	9.E-05	5.E-05	3.E-05	2.E-05	0.359	0.072
53	9.E-07	1.E-07	0.001	2.E-04	0.323	0.065	8.E-06	5.E-06	2.E-06	2.E-06	1.420	0.284
54	5.E-07	1.E-07	0.001	2.E-04	0.041	0.008	2.E-05	1.E-05	5.E-06	3.E-06	0.190	0.038
55	9.E-07	1.E-07	3.E-03	4.E-04	0.230	0.046	1.E-05	7.E-06	3.E-06	2.E-06	1.115	0.223
56	3.E-06	4.E-07	0.002	3.E-04	0.027	0.005	7.E-06	4.E-06	2.E-06	1.E-06	0.127	0.025

Poll.→	31		32		33		34		35		36	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	2.E-06	2.E-06	0.018	0.004	7.E-05	9.E-07	5.E-04	2.E-04	0.008	0.002	4.E-05	4.E-06
2	1.E-06	9.E-07	0.007	0.001	9.E-05	1.E-06	3.E-04	1.E-04	0.003	0.001	9.E-06	9.E-07
3	1.E-06	9.E-07	0.007	0.001	9.E-05	1.E-06	2.E-04	9.E-05	0.003	0.001	8.E-06	8.E-07
4	4.E-06	2.E-06	0.012	0.002	5.E-05	7.E-07	0.001	3.E-04	0.003	0.001	4.E-07	4.E-08
5	9.E-06	7.E-06	0.154	0.031	1.E-04	2.E-06	0.040	0.008	1.093	0.219	7.E-07	7.E-08
6	2.E-06	2.E-06	0.885	0.177	6.E-05	8.E-07	5.E-04	2.E-04	0.005	0.001	3.E-07	3.E-08
7	4.E-05	4.E-05	0.034	0.007	1.E-04	1.E-06	0.001	3.E-04	0.016	0.003	6.E-07	6.E-08
8	2.E-04	2.E-04	0.015	0.003	6.E-05	9.E-07	5.E-04	2.E-04	0.006	0.001	5.E-07	5.E-08
9	3.E-06	3.E-06	0.021	0.004	2.E-04	3.E-06	0.001	2.E-04	0.014	0.003	2.E-05	2.E-06
10	5.E-06	3.E-06	0.022	0.004	2.E-04	2.E-06	0.001	4.E-04	0.019	0.004	2.E-05	2.E-06
11	4.E-06	3.E-06	0.025	0.005	0.001	1.E-05	0.001	3.E-04	0.015	0.003	1.E-05	1.E-06
12	7.E-06	5.E-06	0.024	0.005	1.789	0.025	0.002	0.001	0.029	0.006	5.E-06	5.E-07
13	4.E-06	3.E-06	0.016	0.003	3.E-04	4.E-06	0.001	4.E-04	0.014	0.003	5.E-06	5.E-07
14	3.E-05	2.E-05	0.028	0.006	3.E-04	4.E-06	0.005	0.003	0.023	0.005	8.E-06	8.E-07
15	4.E-05	2.E-05	0.027	0.005	3.E-04	4.E-06	0.007	0.003	0.027	0.005	3.E-06	3.E-07
16	2.E-05	8.E-06	0.021	0.004	2.E-04	3.E-06	0.003	0.001	0.017	0.003	3.E-06	3.E-07
17	4.E-05	2.E-05	0.034	0.007	4.E-04	5.E-06	0.006	0.003	0.033	0.007	3.E-06	3.E-07
18	6.E-06	4.E-06	0.034	0.007	2.E-04	3.E-06	0.002	0.001	0.030	0.006	8.E-06	8.E-07
19	1.E-05	8.E-06	0.015	0.003	2.E-04	2.E-06	0.002	0.001	0.011	0.002	7.E-07	7.E-08
20	2.E-05	1.E-05	0.042	0.008	3.E-04	4.E-06	0.006	0.002	0.103	0.021	3.E-06	4.E-07
21	7.E-05	4.E-05	0.026	0.005	2.E-04	3.E-06	0.011	0.005	0.037	0.007	2.E-06	2.E-07
22	4.E-05	2.E-05	0.020	0.004	3.E-04	4.E-06	0.006	0.003	0.015	0.003	2.E-06	2.E-07
23	7.E-05	4.E-05	0.020	0.004	4.E-04	5.E-06	0.010	0.005	0.015	0.003	3.E-06	3.E-07
24	3.E-05	1.E-05	0.040	0.008	4.E-04	5.E-06	0.005	0.002	0.034	0.007	5.E-06	6.E-07
25	3.E-05	2.E-05	0.044	0.009	4.E-04	6.E-06	0.006	0.003	0.031	0.006	2.E-06	3.E-07
26	5.E-06	3.E-06	0.643	0.129	1.E-04	2.E-06	0.001	0.000	0.008	0.002	6.E-07	6.E-08
27	8.E-06	6.E-06	0.220	0.044	3.E-04	5.E-06	0.011	0.003	0.292	0.058	1.E-06	1.E-07
28	2.E-05	1.E-05	0.064	0.013	3.E-04	4.E-06	0.004	0.001	0.070	0.014	2.E-05	2.E-06
29	2.E-05	2.E-05	0.151	0.030	2.E-04	3.E-06	0.003	0.001	0.046	0.009	6.E-06	6.E-07
30	1.E-05	9.E-06	0.047	0.009	3.E-04	4.E-06	0.003	0.001	0.042	0.008	0.004	4.E-04
31	0.002	0.001	0.055	0.011	0.001	1.E-05	0.311	0.162	0.048	0.010	6.E-06	6.E-07
32	8.E-06	5.E-06	0.036	0.007	4.E-04	6.E-06	0.002	0.001	0.028	0.006	4.E-06	4.E-07
33	2.E-05	1.E-05	0.041	0.008	3.E-04	5.E-06	0.004	0.002	0.046	0.009	9.E-06	1.E-06
34	5.E-05	3.E-05	0.073	0.015	9.E-04	1.E-05	0.008	0.004	0.048	0.010	4.E-06	4.E-07
35	6.E-05	5.E-05	0.046	0.009	2.E-04	3.E-06	0.005	0.002	0.093	0.019	1.E-06	1.E-07
36	4.E-05	4.E-05	0.052	0.010	2.E-04	3.E-06	0.006	0.002	0.160	0.032	1.E-06	1.E-07
37	4.E-05	4.E-05	0.054	0.011	2.E-04	3.E-06	0.003	0.001	0.053	0.011	2.E-06	2.E-07
38	1.E-05	9.E-06	0.056	0.011	3.E-04	4.E-06	0.005	0.001	0.122	0.024	9.E-07	1.E-07
39	2.E-05	1.E-05	0.046	0.009	2.E-04	3.E-06	0.004	0.001	0.068	0.014	1.E-06	1.E-07
40	2.E-05	1.E-05	0.039	0.008	3.E-04	4.E-06	0.004	0.002	0.060	0.012	1.E-06	1.E-07
41	2.E-05	1.E-05	0.038	0.008	3.E-04	4.E-06	0.004	0.002	0.046	0.009	1.E-06	1.E-07
42	1.E-05	8.E-06	0.036	0.007	3.E-04	5.E-06	0.003	0.001	0.039	0.008	1.E-06	1.E-07
43	2.E-05	9.E-06	0.034	0.007	3.E-04	4.E-06	0.003	0.001	0.043	0.009	1.E-06	1.E-07
44	2.E-05	1.E-05	0.033	0.007	3.E-04	4.E-06	0.004	0.001	0.035	0.007	1.E-06	1.E-07
45	1.E-05	8.E-06	0.040	0.008	3.E-04	4.E-06	0.003	0.001	0.035	0.007	3.E-06	3.E-07
46	2.E-04	1.E-04	0.022	0.004	6.E-04	8.E-06	0.027	0.014	0.027	0.005	2.E-06	2.E-07
47	2.E-05	1.E-05	0.028	0.006	2.E-04	3.E-06	0.004	0.002	0.042	0.008	9.E-07	1.E-07
48	2.E-05	1.E-05	0.032	0.006	3.E-04	4.E-06	0.005	0.002	0.038	0.008	1.E-06	1.E-07
49	2.E-05	1.E-05	0.034	0.007	3.E-04	4.E-06	0.004	0.002	0.032	0.006	1.E-06	1.E-07
50	1.E-05	6.E-06	0.032	0.006	3.E-04	4.E-06	0.002	0.001	0.031	0.006	1.E-06	1.E-07
51	2.E-05	1.E-05	0.034	0.007	2.E-04	3.E-06	0.003	0.001	0.032	0.006	2.E-06	2.E-07
52	6.E-05	4.E-05	0.028	0.006	2.E-04	3.E-06	0.007	0.003	0.040	0.008	4.E-06	5.E-07
53	5.E-06	3.E-06	0.113	0.023	2.E-04	3.E-06	0.007	0.002	0.180	0.036	7.E-07	7.E-08
54	1.E-05	7.E-06	0.014	0.003	9.E-05	1.E-06	0.002	0.001	0.016	0.003	1.E-06	1.E-07
55	7.E-06	4.E-06	0.075	0.015	3.E-04	4.E-06	0.002	0.001	0.025	0.005	2.E-06	2.E-07
56	4.E-06	2.E-06	0.009	0.002	0.001	1.E-05	0.001	0.000	0.008	0.002	1.E-06	1.E-07

Appendix 4.2

Total (Direct Plus Indirect) Pollution Intensity of Highly Polluting Sectors, 1993-94

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0.072	0.072	0.072	0.031	0.23	0.037	0.004	0.001	0.001	2.00E-05	0.001	1.00E-04
2	0.341	0.341	0.345	0.051	0.724	0.357	0.005	0.001	0.002	1.00E-04	5.00E-04	9.00E-05
3	0.071	0.071	0.078	0.015	0.066	0.011	0.002	0	0.001	3.00E-05	4.00E-04	7.00E-05
4	0.012	0.012	0.012	0.006	0.024	0.003	0.007	0.001	0.002	2.00E-04	0.001	1.00E-04
5	0.067	0.067	0.083	0.07	0.091	0.015	0.009	0.002	0.001	5.00E-05	0.001	2.00E-04
6	0.016	0.016	0.018	0.013	0.032	0.004	0.004	0.001	4.00E-04	2.00E-05	4.00E-04	8.00E-05
7	0.055	0.055	0.069	0.059	0.076	0.013	0.009	0.002	0.001	3.00E-05	0.001	2.00E-04
8	0.023	0.023	0.027	0.02	0.054	0.007	0.005	0.001	5.00E-04	2.00E-05	0.001	1.00E-04
9	0.081	0.081	0.079	0.034	0.246	0.029	0.006	0.001	0.001	5.00E-05	0.001	2.00E-04
10	0.094	0.094	0.176	0.052	0.34	0.065	0.01	0.002	0.002	1.00E-04	0.002	3.00E-04
11	0.134	0.134	0.123	0.038	0.259	0.073	0.011	0.002	0.003	9.00E-05	0.002	4.00E-04
12	0.267	0.267	11.136	0.195	6.424	0.108	0.011	0.002	0.002	7.00E-05	0.002	4.00E-04
13	0.101	0.101	0.091	0.031	0.12	0.014	0.01	0.002	0.002	0	0.002	0
14	0.205	0.205	0.189	0.072	0.448	0.051	0.34	0.038	0.16	0.015	0.019	0.003
15	0.178	0.178	0.16	0.064	0.379	0.042	0.28	0.032	0.124	0.012	0.02	0.003
16	0.088	0.088	0.075	0.041	0.2	0.023	0.059	0.009	0.011	0.001	0.013	0.002
17	0.567	0.567	0.138	0.085	1.096	0.147	0.745	0.124	0.013	0.001	0.234	0.039
18	0.099	0.099	0.105	0.078	0.145	0.024	0.022	0.003	0.006	0.001	0.003	5.00E-04
19	0.049	0.049	0.045	0.026	0.092	0.011	0.019	0.003	0.004	1.00E-04	0.005	0.001
20	1.365	1.365	1.106	0.148	0.609	0.049	0.021	0.004	0.004	2.00E-04	0.004	0.001
21	0.378	0.378	0.322	0.071	0.275	0.025	0.015	0.003	0.003	2.00E-04	0.003	0.001
22	0.084	0.084	0.099	0.052	0.336	0.051	0.142	0.028	0.005	0	0.006	0.001
23	0.112	0.112	0.223	0.095	1.054	0.156	0.765	0.154	0.004	0	0.005	0.001
24	0.306	0.306	0.166	0.086	0.803	0.265	0.191	0.032	0.009	0.001	0.055	0.009
25	0.333	0.333	0.226	0.081	1.206	0.097	0.349	0.059	0.236	0.001	0.111	0.019
26	0.04	0.04	0.029	0.02	0.061	0.007	0.122	0.025	0.001	3.00E-05	0.001	2.00E-04
27	0.102	0.102	0.087	0.062	0.153	0.019	0.014	0.003	0.002	9.00E-05	0.002	4.00E-04
28	0.38	0.379	0.672	0.257	8.264	0.473	0.028	0.005	0.005	1.00E-04	0.007	0.001
29	0.737	0.737	0.63	0.156	3.292	0.349	0.02	0.004	0.006	1.00E-04	0.004	0.001
30	0.227	0.227	0.276	0.132	1.575	0.108	0.023	0.005	0.006	2.00E-04	0.005	0.001
31	0.181	0.181	0.288	0.146	1.892	0.127	0.069	0.028	0.006	2.00E-04	0.026	0.012
32	2.289	2.289	1.74	0.208	0.962	0.064	0.023	0.004	0.007	3.00E-04	0.005	0.001
33	0.189	0.189	0.219	0.109	1.134	0.091	0.048	0.018	0.007	4.00E-04	0.007	0.001
34	0.824	0.824	0.197	0.092	2.093	0.236	1.063	0.178	0.005	2.00E-04	0.344	0.057
35	0.061	0.061	0.072	0.048	0.198	0.019	0.012	0.002	0.002	7.00E-05	0.002	3.00E-04
36	0.117	0.117	0.142	0.12	0.141	0.025	0.027	0.005	0.012	3.00E-04	0.006	0.001
37	0.102	0.102	0.107	0.065	0.393	0.031	0.018	0.003	0.003	1.00E-04	0.003	5.00E-04
38	0.201	0.201	0.109	0.084	0.212	0.036	0.012	0.002	0.002	9.00E-05	0.002	3.00E-04
39	0.138	0.138	0.145	0.119	0.256	0.031	0.014	0.003	0.003	2.00E-04	0.002	4.00E-04
40	0.112	0.112	0.1	0.075	0.195	0.025	0.014	0.003	0.003	0	0.003	0.001
41	0.106	0.106	0.098	0.074	0.189	0.029	0.02	0.003	0.003	2.00E-04	0.004	0.001
42	0.103	0.103	0.098	0.07	0.193	0.024	0.02	0.004	0.003	2.00E-04	0.004	0.001
43	0.102	0.102	0.09	0.065	0.199	0.024	0.018	0.003	0.004	1.00E-04	0.004	0.001
44	0.118	0.118	0.1	0.065	0.28	0.03	0.047	0.008	0.01	2.00E-04	0.013	0.002
45	0.146	0.146	0.139	0.075	0.767	0.057	0.061	0.01	0.014	3.00E-04	0.017	0.003
46	0.094	0.094	0.1	0.054	0.393	0.031	0.016	0.004	0.002	1.00E-04	0.004	0.001
47	0.096	0.096	0.08	0.059	0.241	0.026	0.026	0.005	0.002	7.00E-05	0.007	0.001
48	0.114	0.114	0.107	0.08	0.2	0.032	0.029	0.005	0.002	1.00E-04	0.008	0.001
49	0.104	0.104	0.098	0.065	0.237	0.031	0.025	0.004	0.005	2.00E-04	0.006	0.001
50	0.102	0.102	0.108	0.075	0.195	0.023	0.014	0.002	0.004	2.00E-04	0.002	4.00E-04
51	0.111	0.111	0.115	0.072	0.455	0.038	0.03	0.005	0.007	2.00E-04	0.007	0.001
52	0.067	0.067	0.064	0.046	0.119	0.016	0.013	0.003	0.002	7.00E-05	0.003	0.001
53	0.571	0.571	0.816	0.801	0.163	0.103	0.012	0.002	0.001	6.00E-05	0.003	4.00E-04
54	0.048	0.048	0.061	0.052	0.054	0.01	0.004	0.001	0.001	0	0.001	1.00E-04
55	0.081	0.081	0.088	0.066	0.099	0.021	0.026	0.005	0.004	1.00E-04	0.004	0.001
56	0.064	0.064	0.062	0.022	0.074	0.009	0.008	0.001	0.001	8.00E-05	0.002	3.00E-04

BT- Before Abatement Values, AT- After Abatement Values. For sectors and pollutants specification, see appendices 3.1 and 3.2

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0.123	0.003	0.285	0.010	0.019	0.001	0.014	0.002	3.E-08	2.E-09	3.E-06	2.E-07
2	0.247	0.013	0.645	0.074	0.041	0.002	0.004	4.E-04	3.E-08	2.E-09	2.E-06	1.E-07
3	0.156	0.005	0.290	0.012	0.005	4.E-04	0.003	4.E-04	7.E-08	5.E-09	2.E-06	1.E-07
4	0.023	5.E-04	0.056	0.003	3.E-04	1.E-04	0.001	5.E-05	2.E-08	2.E-09	4.E-06	2.E-07
5	0.088	0.001	0.218	0.012	0.002	0.001	0.002	1.E-04	3.E-08	2.E-09	1.E-05	5.E-07
6	0.033	5.E-04	0.081	0.003	4.E-04	2.E-04	0.001	7.E-05	1.E-08	9.E-10	2.E-06	8.E-08
7	0.074	0.001	0.183	0.009	0.001	0.001	0.002	0.000	0.000	0.000	2.E-05	7.E-07
8	0.055	0.001	0.134	0.005	0.001	0.000	0.001	0.000	0.000	0.000	8.E-06	4.E-07
9	0.176	0.003	0.442	0.015	0.011	0.001	0.008	0.001	2.E-04	1.E-05	5.E-06	2.E-07
10	0.291	0.005	0.687	0.022	0.045	0.001	0.009	0.001	1.E-07	9.E-09	7.E-06	3.E-07
11	0.195	0.005	0.450	0.024	0.013	0.001	0.005	0.001	7.E-06	4.E-07	1.E-05	5.E-07
12	7.195	0.101	0.449	0.022	0.004	0.001	0.175	0.003	6.E-06	4.E-07	1.E-05	5.E-07
13	0.125	0.003	0.326	0.027	0.004	0.001	0.003	0.000	1.E-07	7.E-09	7.E-06	3.E-07
14	0.246	0.009	0.579	0.048	0.006	0.002	0.004	0.000	9.E-08	3.E-08	1.E-05	6.E-07
15	0.234	0.008	0.552	0.043	0.003	0.002	0.002	0.000	8.E-08	2.E-08	1.E-05	5.E-07
16	0.188	0.005	0.446	0.020	0.002	0.001	0.003	0.000	6.E-06	6.E-06	8.E-06	4.E-07
17	0.721	0.050	1.791	0.146	0.003	0.001	0.002	0.000	1.E-07	3.E-08	1.E-05	5.E-07
18	0.116	0.002	0.284	0.016	0.006	0.001	0.005	4.E-04	5.E-08	5.E-09	2.E-05	7.E-07
19	0.086	0.002	0.214	0.012	0.001	5.E-04	0.001	8.E-05	4.E-08	6.E-09	8.E-06	4.E-07
20	1.008	0.036	2.926	0.433	0.003	0.002	0.003	2.E-04	1.E-07	8.E-09	1.E-05	6.E-07
21	0.376	0.011	1.032	0.117	0.002	0.001	0.002	1.E-04	8.E-08	6.E-09	1.E-05	5.E-07
22	0.258	0.005	0.617	0.022	0.002	0.001	0.002	2.E-04	8.E-08	8.E-09	1.E-04	5.E-06
23	0.543	0.012	1.301	0.039	0.003	0.001	0.002	2.E-04	1.E-07	9.E-09	1.E-05	7.E-07
24	0.716	0.020	1.661	0.077	0.004	0.001	0.005	4.E-04	1.E-07	9.E-09	0.002	1.E-04
25	0.750	0.027	1.829	0.087	0.003	0.001	0.002	2.E-04	8.E-08	7.E-09	2.E-05	8.E-07
26	0.108	0.001	0.223	0.007	0.001	0.001	0.007	0.001	2.E-08	2.E-09	4.E-06	2.E-07
27	0.158	0.003	0.385	0.015	0.002	0.001	0.004	0.002	7.E-08	5.E-09	2.E-05	7.E-07
28	8.966	0.052	21.251	0.164	0.010	0.003	0.007	0.001	7.E-07	4.E-08	1.E-05	5.E-07
29	1.624	0.031	3.648	0.062	0.314	0.008	0.247	0.031	0.000	0.000	1.E-05	0.000
30	1.653	0.015	3.959	0.063	0.015	0.003	0.011	0.001	2.E-07	1.E-08	1.E-05	5.E-07
31	2.035	0.020	4.886	0.098	0.006	0.003	0.003	3.E-04	2.E-07	1.E-08	1.E-05	5.E-07
32	2.055	0.135	6.764	0.615	0.103	0.051	0.002	2.E-04	1.E-06	7.E-08	1.E-05	7.E-07
33	1.185	0.010	2.841	0.052	0.006	0.002	0.005	0.000	2.E-07	1.E-08	1.E-05	5.E-07
34	1.614	0.076	3.946	0.222	0.004	0.001	0.003	3.E-04	1.E-07	1.E-08	1.E-05	5.E-07
35	0.209	0.002	0.504	0.014	0.002	0.001	0.002	0.000	0.000	0.000	1.E-05	5.E-07
36	0.113	0.003	0.283	0.020	0.003	0.002	0.003	0.000	0.000	0.000	1.E-05	7.E-07
37	0.418	0.004	0.999	0.018	0.002	0.001	0.003	0.000	0.000	0.000	1.E-05	5.E-07
38	0.221	0.005	0.512	0.021	0.002	0.001	0.094	0.003	6.E-08	4.E-09	1.E-05	6.E-07
39	0.261	0.003	0.632	0.021	0.003	0.002	0.010	0.000	6.E-08	4.E-09	1.E-05	5.E-07
40	0.199	0.003	0.480	0.018	0.002	0.001	0.025	0.001	6.E-08	5.E-09	1.E-05	6.E-07
41	0.189	0.003	0.456	0.018	0.002	0.001	0.018	0.001	6.E-08	4.E-09	6.E-05	3.E-06
42	0.195	0.003	0.474	0.019	0.002	0.001	0.016	0.001	7.E-08	6.E-09	2.E-05	8.E-07
43	0.201	0.003	0.484	0.017	0.002	0.001	0.021	0.001	6.E-08	4.E-09	2.E-05	7.E-07
44	0.263	0.005	0.639	0.025	0.002	0.001	0.012	0.001	6.E-08	4.E-09	1.E-05	5.E-07
45	0.782	0.009	1.872	0.037	0.002	0.001	0.007	3.E-04	1.E-07	7.E-09	1.E-05	6.E-07
46	0.422	0.005	1.020	0.025	0.002	0.001	0.011	4.E-04	1.E-07	8.E-09	7.E-06	3.E-07
47	0.242	0.004	0.578	0.017	0.002	0.001	0.020	0.001	4.E-08	3.E-09	9.E-06	4.E-07
48	0.195	0.004	0.473	0.021	0.002	0.001	0.014	0.001	6.E-08	5.E-09	8.E-05	4.E-06
49	0.239	0.004	0.578	0.021	0.002	0.001	0.012	0.001	7.E-08	6.E-09	7.E-05	3.E-06
50	0.203	0.003	0.495	0.020	0.002	0.001	0.010	4.E-04	6.E-08	4.E-09	1.E-05	5.E-07
51	0.469	0.005	1.125	0.025	0.002	0.001	0.009	0.000	7.E-08	6.E-09	1.E-05	6.E-07
52	0.117	0.002	0.285	0.012	0.002	0.001	0.010	0.000	0.000	0.000	1.E-05	5.E-07
53	0.070	0.002	0.242	0.077	0.013	0.012	0.002	1.E-04	4.E-08	3.E-09	1.E-05	5.E-07
54	0.055	0.001	0.133	0.008	0.001	0.001	0.002	1.E-04	2.E-08	1.E-09	3.E-06	1.E-07
55	0.092	0.002	0.226	0.016	0.002	0.001	0.003	2.E-04	0.000	3.E-09	6.E-05	3.E-06
56	0.086	0.003	0.226	0.016	0.003	0.001	0.002	1.E-04	2.E-07	1.E-08	4.E-06	2.E-07

Poll.→	13		14		15		16		17		18	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0.003	4.E-04	0.002	3.E-04	0.000	1.E-04	0.004	0.000	2.E-04	6.E-05	0.030	0.004
2	0.001	1.E-04	0.001	8.E-05	2.E-04	1.E-04	0.001	0.000	9.E-05	3.E-05	0.007	0.001
3	0.001	1.E-04	5.E-04	8.E-05	2.E-04	9.E-05	0.001	0.000	9.E-05	3.E-05	0.007	0.001
4	3.E-05	3.E-06	2.E-05	3.E-06	0.001	0.000	0.001	0.000	2.E-04	1.E-04	0.000	0.000
5	6.E-05	7.E-06	4.E-05	6.E-06	0.001	0.000	0.001	0.000	2.E-04	9.E-05	0.001	0.000
6	2.E-05	3.E-06	1.E-05	2.E-06	0.000	2.E-04	0.000	0.000	1.E-04	5.E-05	0.000	0.000
7	5.E-05	6.E-06	3.E-05	5.E-06	0.000	2.E-04	0.000	0.000	1.E-04	7.E-05	0.001	0.000
8	4.E-05	5.E-06	3.E-05	4.E-06	0.000	2.E-04	0.000	0.000	0.000	5.E-05	0.001	0.000
9	0.002	2.E-04	0.001	2.E-04	0.000	2.E-04	0.002	0.000	2.E-04	7.E-05	0.017	0.002
10	0.002	3.E-04	0.001	2.E-04	0.001	0.000	0.003	0.000	3.E-04	1.E-04	0.018	0.002
11	0.001	1.E-04	0.001	1.E-04	0.001	3.E-04	0.003	0.000	2.E-04	1.E-04	0.011	0.002
12	5.E-04	6.E-05	3.E-04	5.E-05	0.001	0.000	0.745	0.010	3.E-04	0.000	0.777	0.012
13	5.E-04	6.E-05	3.E-04	5.E-05	0.001	4.E-04	0.001	0.000	0.000	0.000	0.005	0.001
14	0.001	9.E-05	5.E-04	7.E-05	0.006	0.003	0.041	0.004	0.002	0.001	0.007	0.001
15	3.E-04	4.E-05	2.E-04	3.E-05	0.008	0.004	0.031	0.003	0.002	0.001	0.003	0.001
16	2.E-04	3.E-05	1.E-04	2.E-05	0.003	0.002	0.004	0.000	0.001	0.000	0.003	0.001
17	3.E-04	4.E-05	2.E-04	3.E-05	0.007	0.004	0.004	0.000	0.002	0.001	0.003	0.001
18	0.001	9.E-05	5.E-04	7.E-05	0.001	0.001	0.004	0.000	3.E-04	2.E-04	0.007	0.001
19	5.E-05	7.E-06	3.E-05	5.E-06	0.002	0.001	0.002	0.000	0.001	3.E-04	0.001	0.001
20	3.E-04	3.E-05	2.E-04	3.E-05	0.003	0.002	0.002	0.000	0.001	5.E-04	0.003	0.001
21	1.E-04	2.E-05	8.E-05	1.E-05	0.013	0.007	0.001	0.000	0.004	0.002	0.002	0.001
22	2.E-04	3.E-05	1.E-04	2.E-05	0.008	0.004	0.032	0.006	0.002	0.001	0.002	0.001
23	2.E-04	3.E-05	1.E-04	2.E-05	0.014	0.007	0.197	0.039	0.004	0.002	0.003	0.001
24	0.001	6.E-05	3.E-04	5.E-05	0.005	0.003	0.005	0.000	0.001	0.001	0.005	0.001
25	2.E-04	3.E-05	1.E-04	2.E-05	0.006	0.003	0.140	0.001	0.002	0.001	0.003	0.001
26	5.E-05	6.E-06	3.E-05	4.E-06	0.001	0.000	0.000	0.000	2.E-04	1.E-04	0.001	0.000
27	1.E-04	1.E-05	7.E-05	1.E-05	0.001	0.001	0.001	0.000	3.E-04	2.E-04	0.002	0.001
28	0.001	2.E-04	8.E-04	1.E-04	0.002	0.001	0.004	0.000	0.001	3.E-04	0.012	0.002
29	0.063	0.008	0.040	0.006	0.001	0.001	0.050	0.006	0.003	0.001	0.552	0.070
30	0.002	3.E-04	0.001	2.E-04	0.002	0.001	0.073	0.001	0.001	3.E-04	0.025	0.004
31	4.E-04	5.E-05	2.E-04	4.E-05	0.427	0.223	0.004	0.000	0.118	0.061	0.005	0.001
32	3.E-04	3.E-05	2.E-04	3.E-05	0.001	0.001	0.004	0.000	4.E-04	2.E-04	0.004	0.001
33	0.001	1.E-04	5.E-04	8.E-05	0.004	0.002	0.004	0.000	0.001	0.001	0.011	0.001
34	4.E-04	5.E-05	3.E-04	4.E-05	0.009	0.005	0.003	0.000	0.002	0.001	0.005	0.001
35	9.E-05	1.E-05	6.E-05	9.E-06	0.003	0.001	0.001	0.000	0.001	4.E-04	0.001	0.000
36	9.E-05	1.E-05	6.E-05	9.E-06	0.001	0.000	0.007	0.000	3.E-04	0.000	0.001	0.000
7	1.E-04	1.E-05	7.E-05	1.E-05	0.002	0.001	0.002	0.000	0.001	0.000	0.002	0.001
38	7.E-05	9.E-06	5.E-05	7.E-06	0.001	0.001	0.004	0.000	0.000	0.000	0.003	0.002
39	9.E-05	1.E-05	6.E-05	9.E-06	0.002	0.001	0.002	0.000	0.000	0.000	0.052	0.051
40	8.E-05	1.E-05	5.E-05	8.E-06	0.003	0.002	0.002	0.000	0.001	4.E-04	0.007	0.006
41	8.E-05	1.E-05	5.E-05	8.E-06	0.003	0.002	0.002	0.000	0.001	5.E-04	0.003	0.002
42	9.E-05	1.E-05	5.E-05	8.E-06	0.002	0.001	0.002	0.000	0.001	3.E-04	0.003	0.002
43	8.E-05	9.E-06	5.E-05	7.E-06	0.003	0.001	0.003	0.000	0.001	4.E-04	0.004	0.003
44	1.E-04	1.E-05	6.E-05	9.E-06	0.003	0.002	0.006	0.000	0.001	4.E-04	0.007	0.007
45	2.E-04	2.E-05	1.E-04	2.E-05	0.002	0.001	0.008	0.000	0.001	3.E-04	0.012	0.011
46	1.E-04	2.E-05	8.E-05	1.E-05	0.036	0.019	0.002	0.000	0.010	0.005	0.002	0.001
47	7.E-05	9.E-06	4.E-05	7.E-06	0.004	0.002	0.002	0.000	0.001	0.001	0.003	0.002
48	9.E-05	1.E-05	6.E-05	9.E-06	0.005	0.002	0.002	0.000	0.001	0.001	0.003	0.002
49	1.E-04	1.E-05	6.E-05	9.E-06	0.004	0.002	0.003	0.000	0.001	0.001	0.002	0.002
50	8.E-05	1.E-05	5.E-05	8.E-06	0.002	0.001	0.002	0.000	0.001	0.000	0.003	0.002
51	1.E-04	2.E-05	9.E-05	1.E-05	0.003	0.001	0.004	0.000	0.001	0.000	0.007	0.005
52	2.E-04	2.E-05	1.E-04	2.E-05	0.008	0.004	0.002	0.000	0.002	0.001	0.002	0.001
53	6.E-05	7.E-06	4.E-05	6.E-06	0.001	0.000	0.001	0.000	2.E-04	1.E-04	0.001	0.000
54	6.E-05	8.E-06	4.E-05	6.E-06	0.002	0.001	0.000	0.000	5.E-04	2.E-04	0.001	0.000
55	1.E-04	2.E-05	9.E-05	1.E-05	0.001	0.001	0.002	0.000	3.E-04	2.E-04	0.002	0.001
56	1.E-04	1.E-05	7.E-05	1.E-05	0.001	0.000	0.001	0.000	2.E-04	9.E-05	0.002	0.000

Poll.→	19		20		21		22		23		24	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	3.E-04	7.E-05	7.E-05	3.E-06	6.E-06	3.E-06	1.E-05	2.E-07	3.E-04	4.E-05	5.E-06	2.E-06
2	7.E-05	2.E-05	4.E-05	3.E-06	5.E-06	2.E-06	6.E-06	2.E-07	9.E-05	1.E-05	4.E-06	2.E-06
3	6.E-05	2.E-05	5.E-05	4.E-06	5.E-06	2.E-06	7.E-06	2.E-07	1.E-04	1.E-05	4.E-06	2.E-06
4	2.E-05	6.E-06	9.E-05	4.E-06	2.E-05	1.E-05	1.E-05	4.E-07	1.E-05	1.E-06	2.E-05	8.E-06
5	9.E-05	5.E-06	4.E-04	1.E-05	2.E-05	8.E-06	6.E-05	1.E-06	3.E-05	3.E-06	1.E-05	7.E-06
6	3.E-05	3.E-06	2.E-04	8.E-06	8.E-06	4.E-06	3.E-05	6.E-07	1.E-05	1.E-06	7.E-06	4.E-06
7	8.E-05	4.E-06	2.E-04	8.E-06	1.E-05	6.E-06	3.E-05	6.E-07	3.E-05	3.E-06	9.E-06	5.E-06
8	7.E-05	3.E-06	1.E-04	4.E-06	9.E-06	4.E-06	2.E-05	3.E-07	2.E-05	2.E-06	7.E-06	4.E-06
9	1.E-04	4.E-05	1.E-04	7.E-06	1.E-05	5.E-06	2.E-05	5.E-07	2.E-04	2.E-05	8.E-06	4.E-06
10	2.E-04	4.E-05	1.E-04	6.E-06	2.E-05	9.E-06	2.E-05	5.E-07	2.E-04	3.E-05	1.E-05	8.E-06
11	1.E-04	3.E-05	1.E-04	8.E-06	2.E-05	8.E-06	2.E-05	6.E-07	2.E-04	2.E-05	1.E-05	6.E-06
12	1.E-04	2.E-05	3.E-04	1.E-05	2.E-05	1.E-05	4.E-05	9.E-07	8.E-05	1.E-05	2.E-05	9.E-06
13	8.E-05	1.E-05	2.E-04	1.E-05	2.E-05	8.E-06	4.E-05	9.E-07	9.E-05	1.E-05	1.E-05	7.E-06
14	0.001	9.E-05	2.E-04	1.E-05	1.E-04	8.E-05	3.E-05	2.E-06	1.E-04	1.E-05	1.E-04	6.E-05
15	5.E-04	8.E-05	2.E-04	1.E-05	2.E-04	1.E-04	3.E-05	2.E-06	7.E-05	9.E-06	1.E-04	8.E-05
16	1.E-04	2.E-05	3.E-04	1.E-05	7.E-05	4.E-05	4.E-05	1.E-06	6.E-05	7.E-06	6.E-05	3.E-05
17	2.E-04	5.E-05	2.E-04	1.E-05	2.E-04	8.E-05	3.E-05	2.E-06	7.E-05	9.E-06	1.E-04	7.E-05
18	1.E-04	2.E-05	3.E-04	1.E-05	3.E-05	1.E-05	5.E-05	1.E-06	1.E-04	1.E-05	2.E-05	1.E-05
19	5.E-05	1.E-05	2.E-04	8.E-06	4.E-05	2.E-05	3.E-05	9.E-07	3.E-05	4.E-06	3.E-05	2.E-05
20	1.E-04	3.E-05	2.E-04	1.E-05	8.E-05	4.E-05	4.E-05	1.E-06	7.E-05	8.E-06	7.E-05	3.E-05
21	2.E-04	8.E-05	2.E-04	1.E-05	3.E-04	2.E-04	4.E-05	3.E-06	5.E-05	6.E-06	2.E-04	1.E-04
22	0.001	2.E-04	2.E-04	1.E-05	2.E-04	1.E-04	3.E-05	2.E-06	7.E-05	9.E-06	2.E-04	8.E-05
23	0.006	0.001	2.E-04	1.E-05	3.E-04	2.E-04	3.E-05	3.E-06	8.E-05	1.E-05	3.E-04	1.E-04
24	3.E-04	5.E-05	3.E-04	1.E-05	1.E-04	6.E-05	5.E-05	2.E-06	9.E-05	1.E-05	9.E-05	5.E-05
25	0.000	4.E-05	2.E-04	1.E-05	1.E-04	8.E-05	4.E-05	2.E-06	5.E-05	7.E-06	1.E-04	6.E-05
26	6.E-05	6.E-06	2.E-04	8.E-06	2.E-05	1.E-05	3.E-05	7.E-07	2.E-04	7.E-06	2.E-05	9.E-06
27	1.E-04	9.E-06	5.E-04	2.E-04	3.E-05	1.E-05	6.E-05	7.E-06	7.E-05	8.E-06	2.E-05	1.E-05
28	2.E-04	4.E-05	3.E-04	2.E-05	5.E-05	2.E-05	5.E-05	1.E-06	2.E-04	3.E-05	4.E-05	2.E-05
29	0.005	0.001	3.E-04	1.E-05	3.E-05	1.E-05	4.E-05	1.E-06	0.005	0.001	2.E-05	1.E-05
30	4.E-04	6.E-05	4.E-04	2.E-05	5.E-05	3.E-05	6.E-05	2.E-06	4.E-04	5.E-05	4.E-05	2.E-05
31	0.005	0.003	3.E-04	0.000	0.010	0.005	2.E-04	0.000	1.E-04	0.000	0.008	0.004
32	1.E-04	1.E-05	0.003	0.001	2.E-04	4.E-05	2.E-04	3.E-05	0.011	0.001	2.E-04	9.E-05
33	0.002	0.000	0.000	0.000	9.E-05	4.E-05	4.E-05	1.E-06	0.000	0.000	7.E-05	4.E-05
34	0.000	0.000	0.000	0.000	2.E-04	1.E-04	4.E-05	2.E-06	0.000	0.000	2.E-04	9.E-05
35	0.000	0.000	0.000	0.000	6.E-05	3.E-05	4.E-05	1.E-06	0.000	0.000	5.E-05	3.E-05
36	0.000	8.E-06	0.000	2.E-05	2.E-05	1.E-05	6.E-05	1.E-06	0.000	5.E-06	2.E-05	9.E-06
37	7.E-05	1.E-05	3.E-04	1.E-05	5.E-05	2.E-05	5.E-05	1.E-06	6.E-05	6.E-06	3.E-05	2.E-05
38	5.E-05	9.E-06	0.017	0.001	3.E-05	1.E-05	0.003	4.E-05	6.E-05	7.E-06	2.E-05	1.E-05
39	9.E-05	1.E-05	0.002	6.E-05	4.E-05	2.E-05	3.E-04	5.E-06	5.E-05	6.E-06	3.E-05	2.E-05
40	7.E-05	2.E-05	0.004	2.E-04	7.E-05	4.E-05	0.001	1.E-05	5.E-05	6.E-06	6.E-05	3.E-05
41	8.E-05	2.E-05	0.003	1.E-04	7.E-05	4.E-05	0.001	9.E-06	5.E-05	6.E-06	6.E-05	3.E-05
42	7.E-05	2.E-05	0.003	1.E-04	5.E-05	3.E-05	5.E-04	8.E-06	6.E-05	8.E-06	4.E-05	2.E-05
43	7.E-05	2.E-05	0.004	1.E-04	6.E-05	3.E-05	0.001	1.E-05	5.E-05	6.E-06	5.E-05	3.E-05
44	0.000	2.E-05	0.002	8.E-05	7.E-05	4.E-05	3.E-04	6.E-06	6.E-05	7.E-06	6.E-05	3.E-05
45	9.E-05	2.E-05	0.001	4.E-05	5.E-05	2.E-05	2.E-04	3.E-06	6.E-05	7.E-06	4.E-05	2.E-05
46	5.E-04	2.E-04	0.002	7.E-05	0.001	4.E-04	3.E-04	1.E-05	9.E-05	1.E-05	7.E-04	4.E-04
47	8.E-05	3.E-05	0.004	1.E-04	1.E-04	5.E-05	0.001	1.E-05	4.E-05	4.E-06	8.E-05	4.E-05
48	1.E-04	3.E-05	0.002	9.E-05	1.E-04	6.E-05	4.E-04	7.E-06	6.E-05	7.E-06	9.E-05	5.E-05
49	1.E-04	3.E-05	0.002	8.E-05	9.E-05	5.E-05	3.E-04	6.E-06	6.E-05	7.E-06	8.E-05	4.E-05
50	6.E-05	1.E-05	0.002	7.E-05	4.E-05	2.E-05	3.E-04	5.E-06	6.E-05	7.E-06	4.E-05	2.E-05
51	1.E-04	2.E-05	0.001	6.E-05	7.E-05	3.E-05	2.E-04	5.E-06	5.E-05	6.E-06	6.E-05	3.E-05
52	1.E-04	5.E-05	0.002	7.E-05	2.E-04	1.E-04	3.E-04	6.E-06	5.E-05	6.E-06	2.E-04	8.E-05
53	4.E-05	6.E-06	3.E-04	1.E-05	2.E-05	8.E-06	5.E-05	1.E-06	4.E-05	5.E-06	1.E-05	7.E-06
54	3.E-05	1.E-05	3.E-04	1.E-05	4.E-05	2.E-05	4.E-05	1.E-06	2.E-05	3.E-06	3.E-05	2.E-05
55	5.E-05	1.E-05	3.E-04	1.E-05	3.E-05	1.E-05	5.E-05	1.E-06	7.E-05	6.E-06	2.E-05	1.E-05
56	3.E-05	7.E-06	2.E-04	2.E-05	2.E-05	8.E-06	3.E-05	1.E-06	2.E-04	2.E-05	1.E-05	8.E-06

Poll.→ Sec.↓	25 BT	25 AT	26 BT	26 AT	27 BT	27 AT	28 BT	28 AT	29 BT	29 AT	30 BT	30 AT
1	4.E-07	3.E-08	0.068	0.009	0.004	0.000	2.E-06	1.E-06	5.E-07	2.E-07	0.000	0.000
2	4.E-07	5.E-08	0.017	0.002	0.001	0.000	2.E-06	9.E-07	4.E-07	2.E-07	0.000	0.000
3	8.E-07	1.E-07	0.016	0.002	0.001	0.000	2.E-06	8.E-07	3.E-07	2.E-07	0.000	0.000
4	2.E-07	2.E-08	0.001	6.E-05	0.000	0.000	7.E-06	4.E-06	2.E-06	8.E-07	0.000	0.000
5	1.E-06	6.E-08	0.001	1.E-04	0.000	0.000	6.E-06	3.E-06	1.E-06	7.E-07	0.000	0.000
6	4.E-07	3.E-08	4.E-04	6.E-05	0.000	0.000	3.E-06	2.E-06	7.E-07	4.E-07	0.000	0.000
7	1.E-06	5.E-08	0.001	0.000	0.000	0.000	4.E-06	2.E-06	9.E-07	5.E-07	0.000	0.000
8	9.E-07	4.E-08	0.001	0.000	0.000	0.000	3.E-06	2.E-06	7.E-07	4.E-07	0.000	0.000
9	8.E-07	9.E-08	0.037	0.005	0.002	0.000	4.E-06	2.E-06	8.E-07	4.E-07	0.000	0.000
10	1.E-06	1.E-07	0.040	0.005	0.002	0.000	7.E-06	4.E-06	1.E-06	8.E-07	0.000	0.000
11	1.E-06	1.E-07	0.023	0.003	0.001	0.000	6.E-06	3.E-06	1.E-06	6.E-07	0.000	0.000
12	1.E-06	1.E-07	0.010	0.001	0.001	0.000	8.E-06	4.E-06	2.E-06	9.E-07	0.000	0.000
13	1.E-06	1.E-07	0.010	0.001	0.001	0.000	6.E-06	3.E-06	1.E-06	7.E-07	0.000	0.000
14	1.E-06	1.E-07	0.014	0.002	0.001	0.000	6.E-05	3.E-05	1.E-05	6.E-06	0.000	0.000
15	1.E-06	1.E-07	0.006	0.001	0.000	0.000	7.E-05	4.E-05	2.E-05	8.E-06	0.000	0.000
16	1.E-06	1.E-07	0.005	0.001	0.000	0.000	3.E-05	1.E-05	6.E-06	3.E-06	0.000	0.000
17	1.E-06	1.E-07	0.006	0.001	0.000	0.000	6.E-05	3.E-05	1.E-05	7.E-06	0.000	0.000
18	1.E-06	1.E-07	0.014	0.002	0.001	0.000	1.E-05	5.E-06	2.E-06	1.E-06	0.000	0.000
19	6.E-07	6.E-08	0.001	1.E-04	0.000	0.000	0.000	9.E-06	0.000	2.E-06	0.000	0.000
20	2.E-06	1.E-07	0.005	0.001	0.000	0.000	3.E-05	2.E-05	7.E-06	3.E-06	0.000	0.000
21	1.E-06	1.E-07	0.003	3.E-04	0.000	0.000	1.E-04	6.E-05	3.E-05	1.E-05	0.000	0.000
22	2.E-06	1.E-07	0.004	0.001	0.000	0.000	7.E-05	4.E-05	2.E-05	8.E-06	0.000	0.000
23	1.E-06	2.E-07	0.005	0.001	0.000	0.000	1.E-04	6.E-05	3.E-05	1.E-05	0.000	0.000
24	3.E-06	2.E-07	0.010	0.001	0.001	0.000	4.E-05	2.E-05	9.E-06	5.E-06	0.000	0.000
25	2.E-06	1.E-07	0.004	0.001	0.000	0.000	6.E-05	3.E-05	1.E-05	6.E-06	0.000	0.000
26	8.E-07	5.E-08	0.001	1.E-04	0.000	0.000	8.E-06	4.E-06	2.E-06	9.E-07	0.000	0.000
27	2.E-06	2.E-07	0.002	3.E-04	0.000	0.000	1.E-05	5.E-06	2.E-06	1.E-06	0.000	0.000
28	3.E-06	3.E-07	0.026	0.003	0.001	0.000	2.E-05	1.E-05	4.E-06	2.E-06	0.000	0.000
29	3.E-06	1.E-07	1.261	0.159	0.068	0.009	1.E-05	5.E-06	2.E-06	1.E-06	0.000	0.000
30	6.E-06	5.E-07	0.045	0.006	0.003	0.000	2.E-05	1.E-05	4.E-06	2.E-06	0.012	0.004
31	3.E-06	0.000	0.008	0.001	0.004	0.002	0.004	0.002	0.001	0.000	0.001	0.000
32	2.E-04	3.E-05	0.005	0.001	0.000	0.000	1.E-05	6.E-06	2.E-06	1.E-06	0.000	0.000
33	2.E-05	4.E-07	0.016	0.002	0.002	0.000	3.E-05	2.E-05	7.E-06	4.E-06	0.003	0.000
34	2.E-06	1.E-07	0.008	0.001	0.001	0.000	8.E-05	4.E-05	2.E-05	9.E-06	0.000	0.000
35	1.E-06	9.E-08	0.002	0.000	0.000	0.000	2.E-05	1.E-05	5.E-06	3.E-06	0.000	0.000
36	1.E-06	9.E-08	0.002	0.000	0.000	0.000	8.E-06	4.E-06	2.E-06	9.E-07	0.000	0.000
37	1.E-06	9.E-08	0.002	3.E-04	0.000	0.000	2.E-05	8.E-06	6.E-06	2.E-06	0.000	0.000
38	1.E-06	1.E-07	0.001	2.E-04	0.000	0.000	1.E-05	5.E-06	2.E-06	1.E-06	0.000	0.000
39	1.E-06	1.E-07	0.002	3.E-04	0.000	0.000	1.E-05	8.E-06	3.E-06	2.E-06	0.000	0.000
40	1.E-06	1.E-07	0.002	0.000	0.000	0.000	3.E-05	1.E-05	6.E-06	3.E-06	0.000	0.000
41	1.E-06	1.E-07	0.002	0.000	0.000	0.000	3.E-05	1.E-05	6.E-06	3.E-06	0.000	0.000
42	1.E-06	1.E-07	0.002	2.E-04	0.000	0.000	2.E-05	1.E-05	4.E-06	2.E-06	0.000	0.000
43	1.E-06	1.E-07	0.002	2.E-04	0.000	0.000	2.E-05	1.E-05	5.E-06	3.E-06	0.000	0.000
44	1.E-06	1.E-07	0.002	2.E-04	0.000	0.000	3.E-05	1.E-05	6.E-06	3.E-06	0.000	0.000
45	1.E-06	1.E-07	0.003	4.E-04	0.000	0.000	2.E-05	9.E-06	4.E-06	2.E-06	0.000	0.000
46	2.E-06	2.E-07	0.002	3.E-04	0.000	0.000	3.E-04	2.E-04	7.E-05	4.E-05	0.000	0.000
47	8.E-07	7.E-08	0.001	2.E-04	0.000	0.000	4.E-05	2.E-05	8.E-06	4.E-06	0.000	0.000
48	1.E-06	1.E-07	0.002	2.E-04	0.000	0.000	4.E-05	2.E-05	9.E-06	5.E-06	0.000	0.000
49	1.E-06	1.E-07	0.002	0.000	0.000	0.000	4.E-05	2.E-05	8.E-06	4.E-06	0.000	0.000
50	1.E-06	1.E-07	0.002	0.000	0.000	0.000	2.E-05	9.E-06	4.E-06	2.E-06	0.000	0.000
51	1.E-06	1.E-07	0.003	0.000	0.000	0.000	3.E-05	1.E-05	6.E-06	3.E-06	0.000	0.000
52	9.E-07	1.E-07	0.003	0.000	0.000	0.000	7.E-05	4.E-05	2.E-05	8.E-06	0.000	0.000
53	9.E-07	8.E-08	0.001	0.000	0.000	0.000	6.E-06	3.E-06	1.E-06	7.E-07	0.000	0.000
54	4.E-07	4.E-08	0.001	2.E-04	0.000	0.000	2.E-05	8.E-06	3.E-06	2.E-06	0.000	0.000
55	9.E-07	9.E-08	3.E-03	4.E-04	0.000	0.000	1.E-05	6.E-06	2.E-06	1.E-06	0.000	0.000
56	3.E-06	4.E-07	0.002	3.E-04	0.000	0.000	6.E-06	3.E-06	1.E-06	7.E-07	0.000	0.000

Poll.→ Sec.↓	31 BT	31 AT	32 BT	32 AT	33 BT	33 AT	34 BT	34 AT	35 BT	35 AT	36 BT	36 AT
1	1.E-06	6.E-07	1.E-07	5.E-08	7.E-05	9.E-07	2.E-04	9.E-05	0.000	0.000	4.E-05	4.E-06
2	9.E-07	5.E-07	7.E-08	4.E-08	9.E-05	1.E-06	1.E-04	7.E-05	0.000	0.000	9.E-06	9.E-07
3	9.E-07	5.E-07	7.E-08	4.E-08	9.E-05	1.E-06	1.E-04	7.E-05	0.000	0.000	8.E-06	8.E-07
4	4.E-06	2.E-06	3.E-07	2.E-07	5.E-05	7.E-07	0.001	3.E-04	0.000	0.000	4.E-07	4.E-08
5	3.E-06	2.E-06	3.E-07	1.E-07	1.E-04	2.E-06	0.000	0.000	0.000	0.000	7.E-07	7.E-08
6	2.E-06	9.E-07	1.E-07	7.E-08	6.E-05	8.E-07	3.E-04	1.E-04	0.000	0.000	3.E-07	3.E-08
7	2.E-06	1.E-06	2.E-07	9.E-08	1.E-04	1.E-06	0.000	2.E-04	0.000	0.000	6.E-07	6.E-08
8	2.E-06	9.E-07	1.E-07	7.E-08	6.E-05	9.E-07	3.E-04	1.E-04	0.000	0.000	5.E-07	5.E-08
9	2.E-06	1.E-06	2.E-07	8.E-08	2.E-04	3.E-06	0.000	0.000	0.001	0.000	2.E-05	2.E-06
10	4.E-06	2.E-06	3.E-07	2.E-07	2.E-04	2.E-06	0.001	3.E-04	0.000	0.000	2.E-05	2.E-06
11	3.E-06	2.E-06	2.E-07	1.E-07	0.001	1.E-05	0.000	2.E-04	0.000	0.000	1.E-05	1.E-06
12	4.E-06	2.E-06	3.E-07	2.E-07	1.789	0.025	0.001	0.000	0.000	0.000	5.E-06	5.E-07
13	3.E-06	2.E-06	3.E-07	1.E-07	3.E-04	4.E-06	0.000	3.E-04	0.000	0.000	5.E-06	5.E-07
14	3.E-05	2.E-05	3.E-06	1.E-06	3.E-04	4.E-06	0.005	0.002	0.000	0.000	8.E-06	8.E-07
15	4.E-05	2.E-05	3.E-06	2.E-06	3.E-04	4.E-06	0.006	0.003	0.000	0.000	3.E-06	3.E-07
16	1.E-05	8.E-06	1.E-06	6.E-07	2.E-04	3.E-06	0.002	0.001	0.000	0.000	3.E-06	3.E-07
17	3.E-05	2.E-05	3.E-06	1.E-06	4.E-04	5.E-06	0.005	0.003	0.000	0.000	3.E-06	3.E-07
18	5.E-06	3.E-06	4.E-07	2.E-07	2.E-04	3.E-06	0.001	0.000	0.000	0.000	8.E-06	8.E-07
19	9.E-06	5.E-06	7.E-07	4.E-07	2.E-04	2.E-06	0.001	0.001	0.000	0.000	7.E-07	7.E-08
20	2.E-05	9.E-06	1.E-06	7.E-07	3.E-04	4.E-06	0.002	0.001	0.000	0.000	3.E-06	4.E-07
21	7.E-05	3.E-05	5.E-06	3.E-06	2.E-04	3.E-06	0.010	0.005	0.000	0.000	2.E-06	2.E-07
22	4.E-05	2.E-05	3.E-06	2.E-06	3.E-04	4.E-06	0.006	0.003	0.000	0.000	2.E-06	2.E-07
23	7.E-05	4.E-05	5.E-06	3.E-06	4.E-04	5.E-06	0.010	0.005	0.000	0.000	3.E-06	3.E-07
24	2.E-05	1.E-05	2.E-06	1.E-06	4.E-04	5.E-06	0.004	0.002	0.000	0.000	5.E-06	6.E-07
25	3.E-05	2.E-05	3.E-06	1.E-06	4.E-04	6.E-06	0.005	0.002	0.000	0.000	2.E-06	3.E-07
26	4.E-06	2.E-06	3.E-07	2.E-07	1.E-04	2.E-06	0.001	3.E-04	0.000	0.000	6.E-07	6.E-08
27	5.E-06	3.E-06	4.E-07	2.E-07	3.E-04	5.E-06	0.001	0.000	0.000	0.000	1.E-06	1.E-07
28	1.E-05	5.E-06	8.E-07	4.E-07	3.E-04	4.E-06	0.001	0.001	0.000	0.000	2.E-05	2.E-06
29	6.E-06	3.E-06	4.E-07	2.E-07	2.E-04	3.E-06	0.001	0.000	0.000	0.000	6.E-06	6.E-07
30	1.E-05	5.E-06	8.E-07	4.E-07	3.E-04	4.E-06	0.001	0.001	0.000	0.000	0.004	4.E-04
31	0.002	0.001	2.E-04	9.E-05	0.001	1.E-05	0.310	0.161	0.000	0.000	6.E-06	6.E-07
32	6.E-06	3.E-06	5.E-07	3.E-07	4.E-04	6.E-06	0.001	0.000	0.000	0.000	4.E-06	4.E-07
33	2.E-05	9.E-06	1.E-06	8.E-07	3.E-04	5.E-06	0.003	0.001	0.000	0.000	9.E-06	1.E-06
34	4.E-05	2.E-05	4.E-06	2.E-06	9.E-04	1.E-05	0.006	0.003	0.000	0.000	4.E-06	4.E-07
35	1.E-05	7.E-06	1.E-06	5.E-07	2.E-04	3.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
36	5.E-06	2.E-06	4.E-07	2.E-07	2.E-04	3.E-06	0.001	0.000	0.000	0.000	1.E-06	1.E-07
37	8.E-06	4.E-06	7.E-07	3.E-07	2.E-04	3.E-06	0.001	0.001	0.000	0.000	2.E-06	2.E-07
38	6.E-06	3.E-06	4.E-07	2.E-07	3.E-04	4.E-06	0.001	0.000	0.000	0.000	9.E-07	1.E-07
39	8.E-06	4.E-06	6.E-07	3.E-07	2.E-04	3.E-06	0.001	0.001	0.000	0.000	1.E-06	1.E-07
40	1.E-05	8.E-06	1.E-06	6.E-07	3.E-04	4.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
41	2.E-05	8.E-06	1.E-06	6.E-07	3.E-04	4.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
42	1.E-05	6.E-06	9.E-07	5.E-07	3.E-04	5.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
43	1.E-05	7.E-06	1.E-06	5.E-07	3.E-04	4.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
44	2.E-05	8.E-06	1.E-06	6.E-07	3.E-04	4.E-06	0.002	0.001	0.000	0.000	1.E-06	1.E-07
45	1.E-05	5.E-06	8.E-07	4.E-07	3.E-04	4.E-06	0.001	0.001	0.000	0.000	3.E-06	3.E-07
46	2.E-04	9.E-05	1.E-05	7.E-06	6.E-04	8.E-06	0.026	0.014	0.000	0.000	2.E-06	2.E-07
47	2.E-05	1.E-05	2.E-06	8.E-07	2.E-04	3.E-06	0.003	0.002	0.000	0.000	9.E-07	1.E-07
48	2.E-05	1.E-05	2.E-06	1.E-06	3.E-04	4.E-06	0.003	0.002	0.000	0.000	1.E-06	1.E-07
49	2.E-05	1.E-05	2.E-06	8.E-07	3.E-04	4.E-06	0.003	0.002	0.000	0.000	1.E-06	1.E-07
50	9.E-06	5.E-06	7.E-07	4.E-07	3.E-04	4.E-06	0.001	0.001	0.000	0.000	1.E-06	1.E-07
51	1.E-05	7.E-06	1.E-06	6.E-07	2.E-04	3.E-06	0.002	0.001	0.000	0.000	2.E-06	2.E-07
52	4.E-05	2.E-05	3.E-06	2.E-06	2.E-04	3.E-06	0.006	0.003	0.000	0.000	4.E-06	5.E-07
53	3.E-06	2.E-06	3.E-07	1.E-07	2.E-04	3.E-06	0.000	0.000	0.000	0.000	7.E-07	7.E-08
54	8.E-06	4.E-06	7.E-07	3.E-07	9.E-05	1.E-06	0.001	0.001	0.000	0.000	1.E-06	1.E-07
55	6.E-06	3.E-06	5.E-07	3.E-07	3.E-04	4.E-06	0.001	0.000	0.000	0.000	2.E-06	2.E-07
56	3.E-06	2.E-06	3.E-07	1.E-07	0.001	1.E-05	0.000	2.E-04	0.000	0.000	1.E-06	1.E-07

Chapter 5

Industrial Structure, Technical Change and Effluent Generation

The role of technology in determining the level of pollution has been neglected since long. Until recently, pollution problems were viewed as undesirable but relatively unimportant side effects of technical change. The increase in the range and scope of pollution problems due to accumulation of the long-lived pollutants, and higher preferences for environmental quality, has placed new demands on technology. Hence technology becomes a determining factor that influence the environment in every aspect. Understanding the process of change in technology would greatly facilitate the design of environmentally benign policies. How the technological change over the years has caused changes in the generation of pollution, is the central issue of this chapter.

The role of technology in input-output ($I - O$) is not confined to the environmental technology as a pollution control device, re-use system or an environmentally improved system. The technology in $I - O$ is depicted in technological coefficients or the input utilization matrix of the different sectors of the $I - O$ table. As Kemp (1997) mentions, input material change is a form of pollution prevention techniques. Hence the improvement in environmental quality or reduction in pollution is possible through the better use of inputs in the process of production. Understanding how technological

change in the process of production has led to the change in the generation of pollution, would greatly help in designing efficient policies for environmental protection.

In this chapter role of technology in the generation of pollution has been assessed by using the $I-O$ tables of the Indian economy. In the next section we will present a brief sketch of the basic $I-O$ model to be used for this purpose followed by the sections on result, discussions and summary.

5.1 Methodology

As we have already mentioned, technology is an important determinant responsible for much of the industrial pollution. The technological structure in input-output is depicted by the structural coefficients of the conventional sectors. These structural coefficients are expressed in the form of production function (see Camerson 1952). This implies that for each sector there is specified production function which is relatively fixed for the year in which input-output table is being constructed. Change in technology only indicates change in relationships among different sectors and change in primary input requirements. To measure the technological change, we, therefore, take two $I-O$ tables of different time periods and keep the final demand vector constant. Then, the level of output is calculated with different technological matrices (say for period '0' and period 't') but with same final demand (say period '0') vector (see section 2.6.1). If more output is produced in time period 't', it means improved technology has brought more output and a fall in output implies deterioration in technology. In this way change in output becomes a resultant factor of change in technology during two time periods.

We know that the level of pollution directly varies with the change in the level of output. Technology is an important factor that causes change in output as well as change in pollution generation. Thus, there is an interdependence between the undesirable pollutants and the production level. The effect of technology on pollution

generation is explained in terms of structural coefficients matrix. In order to capture this effect the above mentioned approach is followed.

The basic methodology of technological change is adopted from Carter (1970), Leontief (1972) and Forssell (1988). In simple terminology, this model is presented by comparing two $I-O$ tables for the base period $'0'$ and current period $'t'$. As already mentioned in equation (2.40), the total pollution generation is depicted by the product–

$$A_{21}(I-A_{11})^{-1}Y_k \tag{5.1}$$

On the same argument technological change can be defined as the difference in the total pollution generation between year '0' and year 't'. The following relationship explains the technological effect on pollution generation–

$$X_{0-t}=A_{21}(I-A_{11}^{t})^{-1}Y_k^0-A_{21}(I-A_{11}^{0})^{-1}Y_k^0 \tag{5.2}$$

Equation (5.2) describes the effect of technology on pollution generation. A_{21} matrix is the direct pollution generation matrix for the sectors of the input-output table. A_{11} is the usual structural coefficients matrix. Subscripts $'0'$ and $'t'$ indicates the time period. Unlike the case of the technological analysis of the conventional economic sectors, here the positive values of pollution output (in time period $'t'$) does not imply improved technology. In environmental analysis, pollution output should fall as a result of change in technology from time period $'0'$ to time period $'t'$. If the relationship in equation (5.2) gives positive value of pollution then it means over a period of time change in technology has not been environment friendly.

Now, in the present study the basic analytical framework is 'open, static Leontief' type. The role of technology on the generation of pollution has been studied by some simplifying assumptions that only technological matrix changes over time, that final demand is constant and that no change in pollution characteristics of industry's technology take place. This has been done for two reasons– firstly; as already mentioned in chapter three that it is evident from the Central Pollution Control Board (CPCB)

documents that abatement technology for effluent treatment has not changed much in our country[1] though several measures to improve the technology have been taken. But overall the technology to abate pollution has remained more or less same during past several years. Secondly, no industrial pollution database exists in our country and therefore preparation of environmental pollution matrix for different time periods becomes an Herculean task. Thus, it has been assumed that environmental technology does not change with time.

The entire reference period i.e. from 1983-84 to 1993-94 has been divided into two sub-periods. The analysis for all periods and sub-periods can be studied from the following set of equations—

$$X_p^{83-89} = A_{21}(I - A_{11}^{89})^{-1}Y_k^{83} - A_{21}(I - A_{11}^{83})^{-1}Y_k^{83} \tag{5.3}$$

$$X_p^{89-93} = A_{21}(I - A_{11}^{93})^{-1}Y_k^{89} - A_{21}(I - A_{11}^{89})^{-1}Y_k^{89} \tag{5.4}$$

$$X_p^{83-93} = A_{21}(I - A_{11}^{93})^{-1}Y_k^{83} - A_{21}(I - A_{11}^{83})^{-1}Y_k^{83} \tag{5.5}$$

where X_p is the change in pollution over a period of time. The associated superscript represents the year under consideration. Thus, change in pollution attributed to technology between years 1983-84 to 1989-90, 1989-90 to 1993-94 and 1983-84 to 1993-94 are explained in equations (5.3-5.5). A_{21} and A_{11} matrices have predefined meanings.

By using the relationships explained in equation (5.3-5.5) we attempt to calculate the effect of technology on the generation of industrial water pollutants in the economy, over the period 1983-84 to 1993-94. This has been done by examining the pollution generation pattern at the aggregated as well as at the dis-aggregated level.

[1]This has been verified from the CPCB and Uttar Pradesh State Pollution Control Board (SPCB) sources for several industries

5.2 Results and Discussion

It is clear from the above sections that the entire period has been divided into two relevant sub-periods, 1983-84 to 1989-90 and 1989-90 to 1993-94. Along with this we have performed separate analysis for the entire period covering 1983-84 to 1993-94. The same 56-sector aggregation has been followed for 36 different organic, inorganic and toxic pollutants for both before as well as after abatement. Contribution of technological change in the form of changing $a_{ij'}s$, has been estimated in aggregate pollution as well as for individual industrial categories. Also the contribution of highly polluting industries has been examined by taking the pollution coefficients of those sectors separately and assuming pollution from other sectors to be zero. Thus, the effect of technology has been examined from two aspects— firstly, change in aggregate pollution and secondly, change in the level of pollution at an individual industry level. This analysis has been done for all sectors category as well as highly polluting industrial category. All results are shown in tables from 5.1 to 5.6.

5.2.1 Change in Aggregate Pollution Due to Change in Technology

Change in pollution attributed to input technology is shown in table 5.1, 5.2 and 5.3 for the period–1983-84 to 1989-90, 1989-90 to 1993-94 and 1983-84 to 1993-94, respectively. These tables show how much pollution discharged by the various industries would change if we keep final demand vector constant and change the $'A'$ matrix only from the base year to the current year. The first column represents the total pollution generated by all the sectors of the economy, without any abatement measures. The second column illustrates total pollution after abatement. In column 3 and 4 similar information is given for highly polluting industries.

As is clear from the table 5.1 that during 1983-84 to 1989-90 pollution intensity has increased substantially in comparison to the base year technology. If we calculate

the percentage we find that in the case of all sectors effluent quantity has increased by around 26 percent. For highly polluting industries, it has increased by around 30 percent during 1983-84 to 1989-90. Almost all entries of the table depict positive values except for a few instances.

All the major pollution parameters such as insoluble solids (2-6), biological and chemical oxygen demand (7-8), oil and greases (9), nitrogenous pollutants (10-14), have shown sharp increase in pollution. In the case of highly polluting sectors also similar trend has emerged. Phenolic compounds (20) and Cyanides (22) have shown some signs of improvement for highly polluting sectors. The growth has been negative for these two pollutants. Yet, the negative contribution for the two pollutants can not be considered very significant because these negative effects become negligible when compared with high positive growth of other pollutants. As is clear in the case of all industries that, after abatement pollutants have registered high positive growth for all the pollutants, this implies that use of inputs in all the sectors has generated more pollution.

The highly polluting industries have also observed the same positive trend for majority of the pollutants. In the case of all the major pollutants highly polluting sectors have experienced high positive growth. If we calculate the percentage then we find that in the case of highly polluting sectors effluent quantity has increased by around 30 percent. For other pollutants also there has been very sharp increase. The negative growth is shown by very few pollutants. TKN(11), phenolic compounds (20), cyanides (22), and total acids (35) have marginally shown a declining trend for highly polluting sectors. Overall, situation has not been very satisfactory. All sectors have experienced high positive growth. Thus, over a period of time gains of technological progress have not been attributed to environment and therefore results suggest that 1983-84 input technology has been more environment friendly than 1989-90.

Table 5.2 shows the change in pollution due to change in technology during the second sub-period, that is, 1989-90 to 1993-94. In the second sub-period, a slight

Table 5.1: **Change in Pollution Due to Change in Technology, 1983-84 to 1989-90.**

	Absolute Increase in Pollution			
	All Sectors		Highly Polluting Sectors	
S.No.	BT	AT	HIBT	HIAT
1	1536916	1536690	1270683	1270458
2	1294053	452864	1290409	449660
3	2964626	297831	2961728	295061
4	17385571	3465049	376536	63243
5	19416	1188	19416	1188
6	109523	18378	109523	18378
7	2111817	63795	2110766	62841
8	4804111	260586	4795954	252643
9	179518	14551	179217	14250
10	135915	18459	134410	16954
11	3009	3003	-7	-1
12	54	2	54	2
13	34499	4347	34499	4347
14	21984	3382	21984	3382
15	8663	3794	6179	3225
16	8777869	1768917	57252	4380
17	3429	1232	3301	1104
18	533070	106266	328171	44873
19	2794	785	2743	733
20	78	-472	53	-498
21	167	80	165	78
22	7	-97	2	-102
23	4094	634	3965	506
24	137	70	137	70
25	27	6	25	3
26	690536	87055	690484	87003
27	941738	185593	37186	4695
28	134	106	56	29
29	63	57	12	6
30	4444599	888940	856	179
31	108	93	31	16
32	293974	58796	2	1
33	44868	628	44868	628
34	6331	2706	4481	2336
35	50651	10138	-54	-3
36	164	17	164	17

BT- Before Treatment, AT-After Treatment, HIBT- Before Treatment Values for Highly Polluting Sectors, HIAT- After Treatment Values for Highly Polluting Sectors. For pollutants specification, see appendix 3.2.

improvement can be seen, though some of the pollutants still show positive growth trend with 1993-94 technology as compared to 1989-90 technology. Most of the pollutants entries now, register for negative change, which is definitely the result of improved technology from 1989-90 to 1993-94. Most important of all is the reduction in effluent quantity of highly polluting industries. This implies that during 1989-90 to 1993-94, government of India policy of controlling the pollution of highly polluting industries has been successful to an extent. In the case of all the major pollutants such as insoluble solids (2-5), BOD (7), COD (8), oil and greases (9), nitrogenous pollutants (10-14), all metallic and toxic compounds have shown decline in the pollution growth.

In the case of all sectors majority of the pollutants have shown negative contribution. This analysis suggests that 1993-94 technology has been more environment friendly in comparison to 1989-90 technology. The most important result during this sub-period has been the reduction in the pollution from highly polluting sectors.

Table 5.3 shows the results for the entire time period covering 1983-84 to 1993-94. In this analysis the overall situation worsens, which is apparent with the positive entries of all pollutants. The same trend has been observed from all sectors. Highly polluting sectors have again appeared with high pollution growth. All major pollutants have shown high positive contribution for both the categories.

The negative trend is shown by only TKN (11) which is very insignificant in comparison to the high growth of other pollutants. Thus, again these results suggest that over a period of time use of inputs in industries has generated more pollutants. Overall, state of environment can not be regarded satisfactory on account of technological change.

Table 5.2: **Change in Pollution Due to Change in Technology, 1989-90 to 1993-94.**

	Absolute Increase in Pollution			
	All Sectors		Highly Polluting Sectors	
S.No.	BT	AT	HIBT	HIAT
1	440279	440276	-146602	-146596
2	244353	-247606	243105	-248597
3	-884684	-89771	-882650	-88041
4	30825808	6171127	5713	-1257
5	5116	-4326	5116	-4326
6	39303	6510	39303	6510
7	-286550	-10742	-286919	-11133
8	-282324	-3453	-285402	-6616
9	-142808	-600	-142942	-734
10	-94700	-12812	-95378	-13490
11	1356	1349	0	-7
12	183	8	183	8
13	-27907	-3516	-27907	-3516
14	-17784	-2736	-17784	-2736
15	5070	192	-2662	-1387
16	15763604	3161647	-7897	-2971
17	-2097	-493	-2162	-557
18	192222	68363	-259139	-32227
19	-1643	-527	-1668	-553
20	3257	114	3244	101
21	-68	-32	-70	-33
22	525	10	523	8
23	-2672	-272	-2736	-336
24	-57	-29	-57	-29
25	-3	0	-4	-1
26	-558526	-70352	-558552	-70378
27	1624053	326969	-29830	-3784
28	26	14	-24	-13
29	23	21	-5	-3
30	8054788	1610953	977	168
31	32	25	-13	-7
32	541174	108234	-1	-1
33	-33392	-467	-33392	-467
34	4015	183	-1929	-1005
35	162861	32580	-56	-3
36	158	16	158	16

BT- Before Treatment, AT-After Treatment, HIBT- Before Treatment Values for Highly Polluting Sectors, HIAT- After Treatment Values for Highly Polluting Sectors. For pollutants specification, see appendix 3.2.

Table 5.3: **Change in Pollution Due to Change in Technology, 1983-84 to 1993-94.**

	Absolute Increase in Pollution			
	All Sectors		Highly Polluting Sectors	
S.No.	BT	AT	HIBT	HIAT
1	1817307	1817092	1137068	1136854
2	1062264	638511	1058048	634533
3	2138963	210972	2137564	209512
4	40577106	8106969	383197	68188
5	23322	-1573	23322	-1573
6	139372	23333	139372	23333
7	1810622	54635	1809355	53439
8	4459466	258031	4449423	248127
9	60094	14265	59708	13878
10	47464	7258	45531	5325
11	3865	3854	-12	-1
12	183	8	183	8
13	11036	1391	11036	1391
14	7033	1082	7033	1082
15	12518	4139	4788	2501
16	20625356	4144733	44845	1876
17	1896	925	1728	757
18	632413	148871	108962	17427
19	1410	338	1343	271
20	750	122	716	89
21	131	63	128	60
22	101	12	94	5
23	1946	405	1778	237
24	107	55	107	54
25	27	6	23	3
26	220949	27900	220882	27833
27	2158101	430685	12111	1517
28	145	123	44	23
29	76	72	9	5
30	10502623	2100539	1651	315
31	125	113	24	12
32	699578	139916	2	1
33	14508	203	14508	203
34	9358	2988	3475	1811
35	161178	32249	-98	-6
36	292	30	292	30

BT- Before Treatment, AT-After Treatment, HIBT- Before Treatment Values for Highly Polluting Sectors, HIAT- After Treatment Values for Highly Polluting Sectors. For pollutants specification, see appendix 3.2.

5.2.2 Technological Change and Pollution Generation: Share of Individual Industries

The analysis of aggregate pollutants have not given very satisfactory results. In most of the cases aggregate pollutants have shown high positive growth. However, it is not essential that all sectors have experienced same trend in terms of pollution generation. For that reason it is important to analyze the effect of technology on pollution generation at an individual industry level. This sections attempts to examine the sectoral pattern of pollution generation as a result of change in technology. The results of the change in the level of pollution of individual industries because of technological change for all the periods and sub-periods are reported in table 5.4, 5.5 and 5.6. All these results indicate the change in level of pollution because of change in technology over a period of time.

The change in technology during 1983-84 to 1989-90 is shown in table 5.4. It is clear that most of the sectors have contributed positively over a period of time. This indicates an overall degradation of technology in terms of generating more pollution. However, difference in magnitude exist among the different industries and for different pollutants. In case of effluent quantity (1), the sectors with high positive growth includes— other services (56), agriculture (1) and construction (52). Then followed by the dairy product (2), metal products including hand tools (40), other chemicals (33), plastic (25), hydrogenated oil (10). The important sectors with negative growth are— iron-steel (38), transport services (55), heavy chemicals (28), non-ferrous basic metals (39), electricity (53), other livestock product (3), miscellaneous manufacturing (51). Although these sectors indicate improvement in input technology, the change has not been very significant. In terms of percentage the overall contribution of negative growth has been around 8 percent.

In the case of insoluble suspended solids (2-6) the same trend as of above is being observed. Apart from the above mentioned sectors the high positive growth is also observed by the dairy product (2) and forestry (4). Sectors such as edible oil

Table 5.4: **Sectoral Pattern of Change in Pollution Due to Change in Technology, 1983-84 to 1989-90**

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	258907	258824	212878	60487	1112115	90839	2772496	554110	3121	165	3434	586
2	101235	101220	80619	25718	245501	37591	683358	135896	4428	403	1023	180
3	-18018	-18016	-15364	-4896	-32516	-9401	-53901	-10793	-129	-13	193	31
4	11989	11988	7187	3467	14039	1754	290364	57792	1569	142	519	97
5	404	404	228	170	395	49	6260	1252	3	0	9	2
6	467	467	345	240	1835	139	14914	2992	-8	-1	-33	-4
7	-528	-528	-328	-370	-1	-42	-1381	-279	-2	0	9	1
8	-798	-797	-692	-488	-3812	-260	-24476	-4892	3	0	-10	-2
9	22481	22473	20302	8647	81583	7749	163958	32703	463	38	408	70
10	23766	23770	12349	7426	24260	2659	294124	58408	1194	87	1347	232
11	8461	8458	17950	-260	37700	-8924	312800	62353	1179	68	1250	212
12	7658	7658	20667	2454	16887	1648	10506	2072	18	7	224	38
13	22049	22046	18197	6599	33307	3085	171782	34221	380	41	860	146
14	2554	2551	-1873	-782	94810	12671	242239	48424	-14567	-1421	25768	4246
15	7361	7361	-239	593	13285	2345	26509	4996	-1461	-141	5432	899
16	2828	2828	1002	542	5899	812	17246	3424	-566	-55	1217	201
17	-28024	-28031	-25039	-29881	71658	3460	195936	38166	1754	182	6138	991
18	1664	1664	1486	1297	1280	240	8517	1712	-44	-4	7	1
19	633	633	444	250	1678	161	9385	1866	27	2	110	19
20	-564	-564	-527	-218	-299	-49	-1927	-383	-6	0	-21	-4
21	19870	19869	15672	5115	9093	1433	78300	15619	207	22	549	106
22	7284	7285	5715	3923	-1979	-163	92593	18339	883	89	662	124
23	1636	1637	2084	1066	893	355	12987	2587	202	21	202	44
24	12589	12589	6046	5179	7253	-2379	67627	13145	448	35	2385	386
25	25549	25543	9126	5172	59849	6515	125404	24297	-1079	13	7725	1294
26	-4399	-4394	-3692	-1755	-33871	-2081	-60514	-12135	-116	-2	58	8
27	-723	-723	-114	-92	-443	-33	5042	1008	1	0	3	1
28	-10759	-10755	-7957	-4546	-35104	-2996	31523	6360	-173	-6	-871	-151
29	16307	16311	6331	6811	-19044	15	-51208	-10220	-104	2	-341	-58
30	487	488	327	138	-715	-14	3227	643	6	0	13	2
31	1963	1962	1609	777	6709	522	6143	1226	19	1	172	33
32	4192	4195	2503	22	-14864	-805	-3391	-678	-37	-2	35	6
33	36338	36318	28539	13493	130313	8626	171340	34438	-1610	-190	1104	180
34	8748	8749	-320	3693	3553	2150	230438	45688	317	30	3531	591
35	118	118	-69	-49	-223	-18	-1816	-363	-1	0	-1	0
36	-652	-652	-54	-47	116	-4	1153	230	7	0	8	1
37	889	889	4211	3798	-951	467	128814	25747	7	3	129	22
38	-10336	-10336	-4795	-3750	-2487	-677	-81264	-16235	-75	-5	-144	-25
39	-15166	-15166	-8864	-7708	-3424	-1224	-39295	-7863	-70	-4	-121	-22
40	54239	54235	27981	21811	32326	5244	381350	76216	229	16	519	90
41	-4024	-4022	-102	525	-12638	-877	-4599	-943	64	3	116	19
42	-2263	-2263	1031	568	1804	98	33972	6776	-11	3	135	22
43	12868	12862	16789	10677	38532	3350	276635	55195	560	31	847	137
44	4994	4994	7283	3108	11490	1927	122504	24183	218	20	2756	444
45	1248	1248	592	914	-839	64	9333	1851	-113	1	178	30
46	2147	2146	1864	1193	6178	511	17332	3494	17	1	137	40
47	11223	11224	5774	4631	61	693	112457	22481	75	5	133	24
48	-6941	-6943	8087	5127	15940	468	60318	11837	260	24	2488	433
49	-3854	-3854	1139	766	-1465	-451	12002	2374	26	5	76	10
50	-2425	-2425	-740	-661	-2101	-239	-640	-131	-18	0	4	0
51	-21009	-21004	-8986	-4970	-33129	-2563	-14257	-3063	-16	5	1360	227
52	180152	180130	89494	44109	232799	27300	2224851	444148	2381	114	5987	926
53	-16543	-16543	-8173	-8822	388	-894	545255	109039	38	2	126	21
54	-5654	-5652	-8904	-8653	-9356	-1475	794263	158845	13	1	38	5
55	-10497	-10495	8322	4441	11157	4990	984744	196639	1705	34	2817	475
56	824793	824717	746708	265863	849197	103472	5974240	1190238	17804	1420	28826	4989

BT- Before Treatment values, AT- After treatment values. For sectors and pollutants specification, see appendices 3.1 and 3.2.

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	629503	10892	1420607	23238	97568	2559	78512	9958	280	280	6	0
2	139860	3397	327060	12716	20864	962	14322	1776	41	41	3	0
3	-21567	-481	-52830	-2383	-3045	-146	-948	-105	4	4	0	0
4	12122	311	28661	1664	303	86	485	44	8	8	1	0
5	388	6	930	37	6	3	4	1	1	1	0	0
6	2361	25	5991	129	12	10	151	5	0	0	0	0
7	3	3	-28	-22	-4	-5	-1	0	0	0	0	0
8	-4113	-26	-9718	-112	-11	-7	-17	-2	0	0	0	0
9	57012	812	131001	2743	5074	215	3964	495	12	12	0	0
10	-27892	595	-72121	1588	5385	246	6263	833	24	24	1	0
11	30126	871	56748	4033	3630	55	4399	576	9	17	1	0
12	14028	370	14593	1998	836	49	646	70	-1	-1	0	0
13	28389	700	69609	4732	1562	136	1228	154	6	6	1	0
14	52079	4969	121360	10851	2617	-128	2049	276	17	18	10	0
15	4677	997	12637	2575	-14	-9	20	3	1	1	0	0
16	4938	280	11358	740	18	4	35	5	1	1	0	0
17	61473	1654	142061	1297	729	-429	909	108	10	10	1	0
18	629	12	1450	130	125	21	99	11	1	1	0	0
19	1497	31	3492	127	13	3	22	2	0	0	0	0
20	-343	-16	-1003	-163	-8	-3	-3	0	0	0	0	0
21	10992	514	31225	5031	249	88	193	17	0	0	0	0
22	-4992	163	-12164	956	190	81	182	19	2	2	-8	0
23	-1674	60	-4530	359	-32	16	29	2	1	1	1	0
24	811	417	3958	1536	256	78	166	26	2	2	-45	-2
25	51123	1849	124429	5957	280	82	175	21	4	4	0	0
26	-38488	-245	-90951	-941	-78	-38	-308	-37	-1	-1	0	0
27	-491	-2	-1184	-16	-1	-1	-1	0	0	0	0	0
28	-32009	-421	-76159	-1651	-671	-80	-426	-48	-5	-5	0	0
29	-23182	-137	-54994	153	719	128	602	72	-23	-23	0	0
30	-857	8	-1900	89	23	4	10	2	0	0	0	0
31	6850	87	16213	399	39	12	34	3	0	0	0	0
32	-14214	177	-29770	1041	203	97	2	0	0	0	0	0
33	136387	1319	328639	7673	700	191	882	122	2	2	0	0
34	-7182	640	-10428	1790	498	73	298	40	4	4	0	0
35	-234	-2	-554	-16	-2	-1	-2	-1	-2	-2	0	0
36	93	0	185	-7	-2	-1	-16	0	1	1	0	0
37	-1924	36	-4634	583	114	61	7	28	45	45	0	0
38	-1664	-64	-3980	-643	-117	-61	137	-3	-10	-10	-1	0
39	-2164	-81	-5887	-1045	-195	-127	-106	-9	-1	-1	0	0
40	31942	545	77379	4253	590	373	2427	124	31	31	3	0
41	-14470	-102	-34223	-234	5	4	-1123	-41	-1	-1	-1	0
42	1324	2	2828	90	34	4	-1146	-39	1	1	1	0
43	37847	387	90161	2759	380	166	-3920	-118	9	9	3	0
44	5340	611	13468	2461	340	67	-2667	-81	-1	-1	3	0
45	-1672	17	-4180	-16	56	15	67	5	0	0	-1	0
46	6346	72	15020	402	38	18	-31	1	1	1	0	0
47	-697	76	-1147	819	153	84	51	11	5	5	1	0
48	10664	403	27299	2020	245	78	-6651	-228	-2	-2	-11	-1
49	-1985	-21	-4389	69	41	14	-1258	-43	0	0	-4	0
50	-2240	-33	-5427	-170	-2	-8	-115	-4	0	0	0	0
51	-39739	-134	-96374	-1612	-64	-91	-2171	-73	1	2	-2	0
52	179887	4135	414285	20726	10457	1048	11096	2134	2071	2071	16	1
53	1030	48	1425	-612	-73	-126	-143	0	5	5	0	0
54	-9416	-46	-22996	-866	-124	-127	-90	-4	0	0	0	0
55	-5686	645	-18575	1457	1365	127	-658	87	17	17	22	1
56	850991	27472	1930187	141877	28242	8682	28249	2266	432	430	53	2

Poll.→	13		14		15		16		17		18	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	20092	2532	12804	1970	722	403	1433883	287163	1214	250	193167	28014
2	3498	441	2229	343	896	362	347555	69368	332	105	46289	7349
3	-185	-23	-118	-18	-182	-56	-27348	-5425	-26	-10	-6009	-1066
4	36	5	23	4	670	332	146192	29235	173	89	4000	897
5	1	0	0	0	6	2	3181	640	1	0	175	41
6	-2	0	-1	0	85	46	7518	1501	24	13	-93	-22
7	1	0	0	0	-7	-1	-684	-136	0	0	-225	-43
8	-1	0	-1	0	-6	-2	-12456	-2493	-1	0	-273	-59
9	1003	126	639	98	136	55	84228	16830	75	19	11651	1800
10	1715	216	1093	168	385	214	150001	29978	202	73	15625	2174
11	1191	150	759	117	-31	64	159868	31824	119	39	4783	237
12	155	19	98	15	23	17	6113	1044	9	6	1900	95
13	297	37	189	29	178	83	86345	17271	55	23	5273	1259
14	640	81	408	63	-4151	-1851	95708	19535	-851	-453	-25791	-5595
15	9	1	6	1	-492	-236	6082	1256	-119	-62	-1899	-383
16	10	1	6	1	-132	-66	7336	1484	-34	-18	-89	-25
17	237	30	151	23	-2487	-1119	90145	18049	-520	-276	-15454	-3134
18	23	3	14	2	12	3	4409	885	1	0	636	120
19	3	0	2	0	18	9	4616	922	5	3	121	31
20	-1	0	-1	0	-15	-8	-951	-188	-4	-2	12	3
21	29	4	19	3	861	437	39057	7788	229	119	1886	291
22	28	4	18	3	858	437	45650	9110	229	119	1987	406
23	3	0	2	0	606	314	5649	1122	166	86	351	72
24	60	8	39	6	-595	-340	30725	6132	-187	-98	4145	883
25	39	5	25	4	370	177	51207	10403	91	47	2684	557
26	2	0	1	0	-97	-44	-29191	-5831	-21	-11	-1013	-217
27	0	0	0	0	-15	-3	2576	516	0	0	-478	-94
28	-121	-15	-77	-12	-433	-199	16655	3330	-103	-51	-3773	-723
29	112	14	71	11	201	22	-27432	-5656	-11	-8	9068	1539
30	4	0	3	0	-4	-2	1653	325	-1	-1	104	17
31	5	1	3	1	245	124	2911	580	65	34	475	95
32	3	0	2	0	-17	-8	-1759	-351	-4	-2	-87	-32
33	264	33	169	26	-88	-96	87845	17557	-56	-34	8578	1473
34	90	11	57	9	68	51	112286	22521	37	18	166	73
35	0	0	0	0	2	0	-944	-205	-1	0	116	7
36	0	0	0	0	-14	-3	598	125	0	0	-429	-80
37	12	1	8	1	-40	4	65877	13520	8	7	-1227	155
38	-11	-1	-7	-1	-176	-48	-41456	-8357	-11	-6	-5406	-1190
39	-12	-2	-8	-1	-264	-82	-20082	-4011	-26	-13	-7103	-2060
40	32	4	21	3	762	212	194001	38989	54	28	23503	5684
41	3	0	2	0	-89	-28	-2448	-496	-9	-5	-2014	-458
42	8	1	5	1	-51	-14	17160	3442	-3	-2	-1085	-273
43	44	6	28	4	-205	-123	140049	28033	-68	-36	4234	1084
44	55	7	35	5	-1000	-499	58538	11688	-254	-134	-2225	-1395
45	9	1	6	1	54	24	4483	909	11	6	651	138
46	4	1	3	0	996	514	8677	1740	270	141	800	245
47	10	1	7	1	222	75	57110	11444	28	14	5051	1040
48	40	5	26	4	852	507	27080	5406	290	151	-5783	-1081
49	6	1	4	1	-203	-83	5991	1202	-36	-19	-2141	-285
50	1	0	1	0	-56	-20	-331	-66	-7	-4	-1066	-269
51	22	3	14	2	-248	-39	-9033	-1747	3	5	-9744	-2265
52	1900	239	1211	186	-2880	-1891	1146049	242547	-1068	-512	94148	32750
53	10	1	7	1	-311	-56	278647	55758	6	3	-7874	-1564
54	2	0	1	0	-205	-68	406055	81208	-24	-12	567	110
55	266	33	169	26	-273	46	499506	99826	98	47	-11407	-2308
56	2856	360	1820	280	14199	6247	3012769	601673	3077	1555	203609	42246

Poll.→	19		20		21		22		23		24	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	1443	405	76	8	19	10	11	1	1682	225	16	8
2	269	74	113	7	14	7	17	1	339	44	12	6
3	-16	-4	-36	-2	-2	-1	-6	0	-22	-2	-1	-1
4	16	5	49	2	14	7	8	0	11	1	12	6
5	0	0	0	0	0	0	0	0	0	0	0	0
6	1	0	27	1	2	1	4	0	2	0	2	1
7	0	0	0	0	0	0	0	0	0	0	0	0
8	1	0	-2	0	0	0	0	0	0	0	0	0
9	75	21	11	1	2	1	2	0	84	11	2	1
10	99	37	-75	-2	10	5	-12	0	140	19	8	4
11	94	25	-64	-2	5	3	-10	0	107	14	4	2
12	12	3	-27	-1	1	0	-4	0	13	2	1	0
13	28	7	7	1	3	2	1	0	30	4	3	1
14	-16	-10	-69	-3	-74	-39	-11	-1	31	5	-61	-32
15	-8	-3	-3	0	-10	-5	-1	0	-2	0	-8	-4
16	-2	-1	-1	0	-3	-1	0	0	1	0	-2	-1
17	4	-6	8	0	-45	-23	1	0	18	3	-37	-19
18	2	0	2	0	0	0	0	0	2	0	0	0
19	1	0	2	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	17	6	13	1	19	10	2	0	5	1	16	8
22	18	6	10	1	19	10	2	0	6	1	16	8
23	31	8	1	0	14	7	0	0	0	0	11	6
24	-6	-2	-6	0	-16	-8	-1	0	3	1	-13	-7
25	12	3	5	0	7	4	1	0	5	1	6	3
26	-6	0	-28	-1	-2	-1	-4	0	-9	-1	-2	-1
27	0	0	0	0	0	0	0	0	0	0	0	0
28	-18	-5	-1	0	-8	-4	0	0	-10	-2	-7	-3
29	5	1	9	0	-1	-1	1	0	15	0	-1	-1
30	0	0	-1	0	0	0	0	0	1	0	0	0
31	4	2	2	0	5	3	0	0	1	0	4	2
32	0	0	4	1	0	0	0	0	21	3	0	0
33	-2	3	-25	-1	-6	-3	-4	0	24	3	-5	-2
34	11	3	7	0	3	1	1	0	7	1	2	1
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	-3	0	0	0	0	0	0	0	0	0
37	3	1	-15	0	1	0	-2	0	3	2	1	0
38	-3	-1	33	1	-1	0	5	0	-2	-1	-1	0
39	-6	-1	-12	-1	-2	-1	-2	0	-2	0	-2	-1
40	10	2	398	15	4	2	63	1	15	3	4	2
41	-1	0	-201	-7	-1	0	-32	-1	-2	0	-1	0
42	1	0	-211	-8	0	0	-34	-1	0	0	0	0
43	6	0	-737	-26	-6	-3	-117	-2	6	1	-5	-3
44	1	-4	-512	-18	-21	-11	-82	-1	8	1	-18	-9
45	2	0	7	0	1	0	1	0	1	0	1	0
46	12	6	-9	0	23	12	-1	0	0	0	19	10
47	4	1	-2	0	2	1	0	0	4	1	2	1
48	21	7	-1210	-43	24	13	-192	-3	1	0	20	10
49	-1	-1	-228	-8	-3	-2	-36	-1	1	0	-2	-1
50	0	0	-21	-1	-1	0	-3	0	0	0	0	0
51	-12	0	-400	-14	1	0	-64	-1	-5	0	1	0
52	153	48	429	38	-98	-50	67	4	263	108	-80	-42
53	2	0	-33	-1	0	0	-5	0	2	0	0	0
54	-1	0	-16	-1	-2	-1	-3	0	0	0	-2	-1
55	28	8	-323	-11	7	4	-51	-1	32	5	6	3
56	508	139	2583	151	266	131	394	11	1264	178	218	112

Poll.→	25		26		27		28		29		30	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	2	0	402143	50675	166592	31718	15	12	7	6	722404	144503
2	1	0	70021	8823	40447	7811	6	4	2	1	175320	35068
3	0	0	-3706	-467	-3530	-691	0	0	0	0	-13929	-2786
4	0	0	722	91	15254	3049	6	3	1	1	74424	14885
5	0	0	11	1	343	69	0	0	0	0	1622	324
6	0	0	-43	-5	756	152	1	0	0	0	3851	770
7	0	0	13	2	-99	-20	0	0	0	0	-352	-70
8	0	0	-19	-2	-1296	-259	0	0	0	0	-6363	-1273
9	0	0	20078	2530	9829	1886	1	1	0	0	42456	8492
10	0	0	34328	4326	16865	3240	5	3	1	1	75546	15120
11	0	0	23838	3004	16421	3189	2	2	1	1	80550	16111
12	0	0	3093	390	632	114	0	0	0	0	2604	521
13	0	0	5947	750	9293	1835	1	1	0	0	43897	8779
14	0	0	12807	1614	6581	1255	-28	-15	-6	-3	50245	10044
15	0	0	185	23	398	78	-4	-2	-1	0	3268	653
16	0	0	194	25	739	147	-1	-1	0	0	3803	760
17	0	0	4753	599	7060	1387	-17	-9	-4	-2	45727	9144
18	0	0	452	57	524	103	0	0	0	0	2246	449
19	0	0	51	6	479	96	0	0	0	0	2350	470
20	0	0	-18	-2	-95	-19	0	0	0	0	-486	-97
21	0	0	588	74	4203	840	7	4	2	1	19924	3984
22	0	0	570	72	4841	968	8	4	2	1	23174	4634
23	0	0	61	8	538	109	6	3	1	1	2507	501
24	0	0	1211	153	3573	709	-6	-3	-1	-1	15480	3098
25	0	0	771	97	5589	1115	3	2	1	0	26494	5298
26	0	0	41	5	-3087	-617	-1	0	0	0	-14902	-2979
27	0	0	3	0	200	40	0	0	0	0	1315	263
28	0	0	-2426	-306	1250	259	-3	-2	-1	0	8639	1729
29	0	0	2236	281	-1569	-323	-1	-1	-1	-1	-13888	-2778
30	0	0	79	10	178	35	0	0	0	0	836	167
31	0	0	106	13	351	70	2	1	0	0	1473	294
32	0	0	55	7	-186	-38	0	0	0	0	-891	-178
33	0	0	5292	667	9985	1976	-2	-1	0	0	44865	8977
34	0	0	1799	227	11437	2280	1	1	0	0	57420	11484
35	0	0	-4	-1	-76	-15	0	0	0	0	-472	-94
36	0	0	2	0	4	1	0	0	0	0	299	60
37	0	0	238	31	6409	1281	2	1	1	1	33435	6687
38	0	0	-225	-29	-4853	-970	-1	0	0	0	-21108	-4221
39	0	0	-241	-31	-2828	-564	-1	0	0	0	-10232	-2045
40	0	0	651	83	22437	4485	3	2	1	1	98869	19773
41	0	0	69	9	-499	-100	0	0	0	0	-1253	-250
42	0	0	163	21	1606	320	0	0	0	0	8772	1754
43	0	0	886	112	14638	2923	-2	-1	0	0	71393	14278
44	0	0	1100	138	5757	1144	-8	-4	-2	-1	29855	5969
45	0	0	178	22	539	107	0	0	0	0	2319	464
46	0	0	82	10	970	196	9	5	2	1	4420	884
47	0	0	208	26	6417	1283	1	1	0	0	29140	5828
48	0	0	806	102	1991	397	10	5	2	1	13870	2773
49	0	0	122	15	309	61	-1	-1	0	0	3068	614
50	0	0	26	3	-161	-32	0	0	0	0	-164	-33
51	0	0	436	55	-2116	-424	0	0	0	0	-4621	-921
52	2	2	38063	4827	123371	24507	14	32	26	30	574946	114986
53	0	0	208	26	27238	5446	0	0	0	0	142365	28473
54	0	0	39	5	41246	8248	-1	0	0	0	207517	41504
55	0	0	5321	671	48977	9774	3	2	1	1	254498	50900
56	21	3	57170	7211	325867	64961	107	61	27	17	1526051	305196

Poll.→ Sec.	31 BT	31 AT	32 BT	32 AT	33 BT	33 AT	34 BT	34 AT	35 BT	35 AT	36 BT	36 AT
1	12	10	46619	9324	1293	18	514	285	-1481	-297	89	9
2	4	3	12177	2436	399	6	664	265	6950	1390	18	2
3	0	0	-1208	-242	107	1	-138	-42	-2594	-519	-2	0
4	3	2	4958	992	106	1	488	241	1146	229	0	0
5	0	0	114	23	2	0	5	1	78	16	0	0
6	0	0	240	48	-29	0	62	33	-85	-17	0	0
7	0	0	-39	-8	4	0	-5	-1	-142	-28	0	0
8	0	0	-421	-84	-4	0	-4	-1	-74	-15	0	0
9	1	1	2872	574	237	3	101	40	1027	206	5	0
10	3	2	4798	960	278	4	277	154	-838	-168	8	1
11	2	1	4601	920	1640	23	-34	43	-5298	-1050	6	1
12	0	0	135	27	2203	31	17	12	-280	-56	1	0
13	1	1	2925	585	204	3	130	60	681	136	1	0
14	-15	-8	826	165	750	11	-3057	-1352	-20566	-4113	3	0
15	-2	-1	58	11	56	1	-359	-172	-1304	-261	0	0
16	-1	0	226	45	36	1	-96	-48	-173	-35	0	0
17	-9	-5	1584	316	13	0	-1830	-817	-11681	-2336	1	0
18	0	0	173	35	10	0	9	2	234	47	0	0
19	0	0	154	31	10	0	13	7	18	4	0	0
20	0	0	-29	-6	0	0	-11	-6	19	4	0	0
21	4	2	1380	276	97	1	626	318	757	151	0	0
22	4	2	1583	317	160	2	623	317	686	137	0	0
23	3	2	176	35	126	2	440	228	118	24	0	0
24	-3	-2	1236	247	58	1	-427	-246	1964	393	0	0
25	2	1	1839	368	52	1	271	129	1040	208	0	0
26	0	0	-1017	-203	39	1	-72	-32	-435	-87	0	0
27	0	0	48	10	1	0	-12	-2	-319	-64	0	0
28	-2	-1	355	71	-90	-1	-318	-145	-1739	-348	-1	0
29	-1	-1	-260	-52	-51	-1	158	19	5423	1085	-1	0
30	0	0	58	12	2	0	-3	-2	32	6	1	0
31	1	1	123	25	35	0	178	90	232	46	0	0
32	0	0	-63	-13	2	0	-13	-6	-48	-10	0	0
33	-1	-1	3301	660	108	2	-56	-68	3328	666	1	0
34	1	0	3596	719	-604	-8	47	37	-1058	-212	0	0
35	0	0	-20	-4	-1	0	2	0	93	19	0	0
36	0	0	-13	-3	2	0	-10	-2	-277	-55	0	0
37	1	1	1975	395	49	1	-34	1	-1627	-325	0	0
38	0	0	-1711	-342	-74	-1	-134	-36	-2908	-582	0	0
39	0	0	-1100	-220	-56	-1	-199	-60	-3701	-740	0	0
40	2	1	7857	1571	208	3	579	158	12283	2457	0	0
41	0	0	-226	-45	24	0	-67	-21	-1225	-245	0	0
42	0	0	471	94	64	1	-39	-10	-825	-165	0	0
43	-1	0	4757	951	303	4	-146	-89	1107	221	0	0
44	-5	-2	1758	352	264	4	-728	-362	-1486	-297	0	0
45	0	0	187	37	20	0	40	17	308	62	0	0
46	5	3	326	65	32	0	723	373	336	67	0	0
47	1	0	2201	440	50	1	167	56	2651	530	0	0
48	5	3	405	81	221	3	608	366	-4185	-837	0	0
49	-1	0	17	3	42	1	-151	-61	-1541	-308	0	0
50	0	0	-85	-17	12	0	-42	-15	-632	-126	0	0
51	0	0	-997	-199	84	1	-192	-31	-5921	-1184	0	0
52	31	41	40538	8107	2109	30	-2070	-1405	27828	5566	15	2
53	0	0	8403	1681	56	1	-241	-44	-6971	-1394	0	0
54	0	0	13151	2630	21	0	-154	-51	-2523	-505	0	0
55	2	1	15032	3006	512	7	-226	27	-12375	-2475	1	0
56	63	38	107931	21587	33673	471	10458	4553	76622	15322	15	2

(10), food product (11), cotton, woolen and synthetic textile (14,15,17), rubber (24), plastic (25), other chemical (33), engineering (40, 44, 48) have also shown decline of technology in 1989-90. The sectors with negative contribution have been iron-steel (38), heavy chemical (28), other livestock product (3), miscellaneous manufacturing (51), non-ferrous basic metals (39), gas and water supply (54), electricity (53), petroleum product (26) etc.

For the pollutants such as biological and chemical oxygen demand (7,8) the maximum deterioration technology has been observed in other services (56), agriculture product (56),cotton textile (14), construction (52) and dairy product (2), plastic product (25), art silk, synthetic fiber textile (17), other chemical (33) and woolen textile (15). Sectors such as, other livestock product (3), heavy chemicals (28), miscellaneous manufacturing (51) have shown little improvement in terms of input technology.

In this way we find that most of the sectors have experienced positive growth of pollution that indicates deterioration in technology. In the case of most of the pollutants, agriculture (1), construction (52), other services (56), edible oil (10), textile (14,15,17), dairy (2), plastic (25), rubber (24) have shown the highest positive contribution for almost all the pollutants. The sectors showing improvement in technology have been mainly other livestock product (3), heavy chemicals (28) and miscellaneous manufacturing (51). In very few instances cotton textile (14), non-ferrous basic metals (39), engineering (41,43,44,48,49), electricity (53), gas and water supply (54) have shown negative trend. But it has been observed through out the analysis that positive contribution has been very strong and negative contribution was negligible in most of the cases. As a result input technology has caused higher growth of pollution output in 1989-90.

The similar calculations for the sub-period 1989-90 to 1993-94 are shown in table 5.5. As is clear from the table that during 1989-90 to 1993-94 slight improvement in terms of lower increase in pollution growth has been observed, in the case of almost all the pollutants. During this time period, more and more industries under the highly

polluting industrial category have shown negative growth with 1993-94 technology as compared to the 1989-90 technology. The industries that have been found generating high positive contribution during the first sub-period have now started showing negative trend for the majority of the pollutants. Industries such as sugar (9), food products (11), beverages (12), plastic (25), fertilizer (29) and drugs and medicine (32), are now generating negative impact with the 1993-94 technology in comparison to the 1989-90 technology. The most important improvement can be observed in the case of other services (56), and construction (52). We will now examine the overall impact of technology for all the pollutants during the period 1989-90 to 1993-94.

It is clear from the table that in the case of effluent quantity (1), sectors such as transport services (55), construction (52), electrical and electronic equipment (44), petroleum product (26) and motor vehicles (48), have generated 138 percent more pollutants with the 1993-94 technology in comparison to the 1989-90 technology. Printing and publishing (21), non-electrical machinery (43), miscellaneous manufacturing (51) and other chemical (33) have also generated increased effluent quantity with 1993-94 technology. The number of sectors with the negative growth have increased. Now, sugar (9), beverages (12), woolen textile (15), leather and leather product (23), other livestock product (3), art silk, synthetic fiber textile (17), fertilizer (29), dairy product (2), plastic product (25), gas and water supply (54), food product (11), other non-metallic mineral product (37), drugs and medicine (32), metal product including hand tools (40), agriculture product (1) and other services (56) are present with the significant negative contribution. In this way the overall increase in effluent quantity during 1989-90 to 1993-94 has been relatively less in comparison to the earlier sub-period.

Incase of insoluble solids (2-6) we find that other services (56) sector now no more shows positive contribution. This sector has generally shown negative contribution. The sectors with high positive growth have been agriculture (1), construction (52), transport services (55), motor vehicles (48), electrical and electronic equipment (44),plastic product (25), synthetic textile (17), other livestock product (3), sugar (9), cotton textile (14) petroleum product (26). The negative growth is shown by batteries

Table 5.5: **Sectoral Pattern of Change in Pollution Due to Change in Technology, 1989-90 to 1993-94**

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	-63535	-63493	-83233	54864	-768549	-88539	3616275	723223	2396	-12	2005	319
2	-22825	-22819	-22835	47	-115889	-14289	249646	50172	-1051	-132	121	17
3	-8495	-8493	-9218	788	-42969	-5955	144456	28914	1	-15	129	21
4	7682	7681	2039	2251	7985	850	403516	80843	-482	-59	152	29
5	245	245	163	-47	-919	-135	-35280	-7057	-41	-1	-29	-5
6	-1043	-1042	-1463	-1479	-7133	-722	-156075	-31261	-114	-4	-123	-22
7	813	813	122	-57	2202	219	58785	11764	24	1	41	7
8	5937	5933	5107	4447	26543	1412	190376	37972	-153	-8	-207	-36
9	-2517	-2515	-6261	1550	-37362	-4870	370953	74225	-13	-24	190	31
10	4634	4629	-1087	8709	-23517	-6960	270060	54271	-341	-53	43	4
11	-35324	-35321	-46647	-489	-57941	-3852	760008	151971	1022	-13	1202	200
12	-4176	-4174	-30559	-1779	-33003	-2033	41749	8390	-154	-6	12	2
13	9173	9173	3079	1594	-10299	-1573	139751	27979	-167	-11	4	-0.225
14	18018	18021	-27091	5029	-80512	-4688	2343435	476790	-40726	-4211	-1467	-287
15	-5703	-5703	3081	2340	-22367	-3198	152654	30807	3420	309	-7871	-1299
16	1166	1165	-202	353	3545	45	38226	7617	285	17	79	15
17	-11879	-11871	-27971	-11318	-76782	-6608	478350	97180	-6471	-675	-1668	-282
18	-835	-835	-1098	-707	-1993	-336	24025	4791	88	6	34	6
19	4840	4839	2593	1484	5012	589	52416	10460	328	2	308	53
20	14797	14796	15900	5280	6872	952	-22614	-4542	24	6	216	44
21	40482	40478	21628	4426	28320	2428	288210	57717	398	3	338	78
22	2171	2170	-576	741	5548	1066	72992	14768	-729	-96	395	68
23	-6268	-6265	-7284	-2291	-18232	-1077	20889	4183	-386	-53	-101	-42
24	18714	18718	-3521	-59	-5168	2978	340145	67094	-38	-22	8416	1418
25	-24631	-24617	-21565	-10898	-109689	-8500	77932	16123	-1111	-52	-4407	-742
26	69407	69404	6670	4965	20569	2132	8190084	1638083	217	8	333	61
27	11454	11455	-1713	-1155	-5536	-532	-647929	-129606	-76	-4	-57	-10
28	2835	2830	7875	6960	29823	2294	-94427	-18883	-209	-5	93	18
29	-14708	-14709	-1543	1367	-12474	-1817	-704010	-140810	-623	-9	-317	-53
30	175	174	175	168	4499	291	5372	1078	7	0.299	6	1
31	1066	1064	555	457	8263	404	43610	8717	79	2	-243	-49
32	-38261	-38265	-31000	-5917	26241	1014	191908	38390	203	-20	208	32
33	20562	20558	1600	10529	19700	1568	460758	91583	737	65	1539	256
34	42	42	4780	2309	222	69	-54044	-10766	2	8	-702	-124
35	-368	-368	-24	-9	-167	-13	1711	342	-4	-0.115	-4	-1
36	-116	-116	-209	-219	120	-13	2371	470	56	1	23	4
37	-38219	-38229	-20973	-18199	59361	1135	-31647	-6352	737	10	654	108
38	2848	2848	5158	4585	4184	625	-94271	-18841	-143	-5	-98	-16
39	5468	5467	7398	6983	6019	1010	-30069	-5996	-128	-9	-73	-13
40	-45055	-45054	-36602	-31001	-7304	-3966	162397	32329	1195	51	910	145
41	11884	11882	3106	1956	10259	1233	232910	46512	367	21	456	77
42	2651	2650	1141	899	6594	702	199065	39705	662	35	680	111
43	28250	28248	-2440	1	27324	3177	727173	145097	2738	73	2935	487
44	72562	72556	13511	13160	75804	8286	1173053	233922	13663	197	6640	1128
45	2853	2856	-1714	-1361	-15957	-637	80753	16039	897	14	980	164
46	-267	-268	-187	-230	274	-19	1089	208	17	1	-14	-6
47	10298	10297	351	57	12438	1491	38811	7641	362	7	1314	224
48	47071	47080	9985	18529	-52100	-573	851926	170237	817	-8	1395	204
49	6334	6335	-645	-527	-2408	1238	166939	33310	815	9	924	156
50	7055	7055	3318	2672	4699	728	58603	11702	174	10	91	16
51	26489	26465	15765	8868	152420	9067	485408	97107	1994	22	517	88
52	98417	98411	28906	42698	14802	4825	3903310	779834	10415	221	9663	1676
53	18520	18519	6526	5400	9432	1485	650670	130094	262	9	530	89
54	-25382	-25381	-11060	-10814	-6656	-1543	-2003760	-400736	51	-2	93	22
55	319407	319394	185394	157462	147506	35779	6103968	1219815	9199	182	9079	1525
56	-104433	-104436	-204815	-41020	-96339	-16413	833197	166510	4623	-106	3934	594

BT- Before Treatment values, AT- After treatment values. For sectors and pollutants specification, see appendices 3.1 and 3.2.

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	-362139	-7973	-786729	-8638	-77908	-602	-61871	-7672	10	10	19	1
2	-55714	-1309	-122685	-2723	-11467	-242	-8760	-1094	-7	-7	3	0
3	-20208	-546	-45059	-1276	-4512	-101	-3303	-412	-2	-2	2	0
4	8849	77	22044	427	-29	29	109	2	10	10	1	0
5	-789	-6	-2018	-15	19	1	-10	-4	-13	-13	-1	0
6	-6865	-48	-16650	-293	-7	-13	-165	0	1	1	0	0
7	2308	26	5506	98	4	-1	19	2	1	1	1	0
8	30029	96	70137	450	39	58	303	23	-4	-4	-3	0
9	-14499	-384	-29450	-392	-4235	-56	-3267	-409	3	2	2	0
10	27993	-440	75400	1111	-7816	-30	-6244	-786	-2	-2	3	0
11	-41984	-1310	-78705	-9489	-6597	-50	-5473	-669	5	9	11	0
12	-32012	-398	-35665	-699	-697	-33	-859	-63	6	6	1	0
13	1128	47	7784	2021	-1571	0	-1029	-146	3	3	2	0
14	-32517	-1287	-61071	-6681	-2036	-160	-1024	-149	52	52	16	1
15	-12847	-1521	-32627	-3534	-28	47	-20	-2	3	3	1	0
16	2780	-28	8092	118	-146	2	-27	-9	1	1	0	0
17	-69289	-1149	-160208	-5907	-1333	-229	-1084	-115	3	3	5	0
18	-906	-16	-2027	-80	-221	-15	-158	-19	0	0	0	0
19	4557	121	11542	727	32	25	59	4	3	3	1	0
20	10613	435	31103	5132	96	78	40	2	-1	-1	0	0
21	35666	802	94968	8313	91	53	159	15	10	10	3	0
22	5437	89	14034	133	-161	-1	-77	-14	3	3	6	0
23	-25335	-323	-55834	-1270	-450	-61	-321	-36	-1	-1	0	0
24	-18145	1450	-39430	3740	-626	-9	-505	-61	1	1	14	1
25	-108840	-1635	-259213	-6335	-492	-179	-317	-35	-4	-4	1	0
26	20791	236	50353	1304	155	83	371	21	7	7	1	0
27	-5686	-60	-14046	-371	-32	-20	-21	5	-1	-1	0	0
28	32135	130	75189	842	-42	75	-71	-10	-5	-4	-1	0
29	1354	-234	3765	-423	-2163	-25	-1779	-239	-48	-48	-1	0
30	4470	16	10394	-11	40	0	31	4	0	0	0	0
31	9320	1	22469	15	5	6	-28	-1	1	1	0	0
32	11693	-1914	-2431	-10025	-1743	-865	-127	-9	3	3	1	0
33	22863	138	56230	-727	-1186	151	-984	-124	15	15	3	0
34	1294	-67	2361	454	141	38	103	12	1	1	0	0
35	-160	-3	-407	-13	0	0	1	-1	-2	-2	0	0
36	48	5	117	-4	-7	-3	-5	0	1	1	0	0
37	61846	304	145782	-1896	-395	-288	-1444	17	216	216	2	0
38	4466	3	10647	440	102	72	-543	-15	1	1	0	0
39	6011	13	14678	610	131	108	-401	-16	-10	-10	0	0
40	-9370	-92	-23244	-3841	-699	-504	-1407	-53	54	54	1	0
41	9839	209	24281	970	45	38	820	34	8	8	1	0
42	4938	150	13154	646	-9	12	-734	-29	3	3	2	0
43	19353	697	47870	1317	-180	-23	4766	161	21	21	4	0
44	46905	1583	115239	4565	-1	177	6975	267	67	67	3	0
45	-20380	99	-47753	249	-15	-13	220	9	4	4	0	0
46	345	1	896	-12	-4	-3	-28	-1	0	0	0	0
47	10385	376	24770	999	-30	-5	2869	99	4	4	0	0
48	-63412	-66	-146139	-34	35	314	4734	154	32	32	-9	0
49	-6169	182	-13686	662	-59	-14	736	23	3	3	5	0
50	4547	82	11351	660	32	37	544	20	2	2	1	0
51	162246	1016	386812	3773	-29	99	1357	62	58	58	2	0
52	32534	1726	110049	11269	-8273	622	-10316	-693	686	686	26	1
53	8402	192	21498	1298	84	84	190	7	6	6	1	0
54	-5301	25	-14153	-999	-142	-163	99	11	19	19	0	0
55	112609	3539	305497	30857	2968	2497	1647	52	86	86	69	3
56	-91735	-3799	-87104	-20967	-11486	-1596	-8448	-931	37	40	-16	-1

Poll.→	13		14		15		16		17		18	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	-15455	-1947	-9849	-1515	-27	-307	1840144	368280	-1018	-230	-83906	-6847
2	-2201	-277	-1403	-216	-156	-96	127070	25485	-165	-43	-16476	-1933
3	-829	-104	-529	-81	-5	-12	73293	14676	-50	-10	-5525	-584
4	-13	-2	-8	-1	287	131	206716	41411	62	33	4255	907
5	3	0	2	0	14	3	-18235	-3749	0	0	131	-65
6	-1	0	-1	0	-41	-32	-79709	-15951	-17	-11	114	-7
7	1	0	0	0	12	5	29947	5992	3	1	438	93
8	-4	-1	-3	0	-14	-21	96659	19313	-16	-8	2508	536
9	-830	-105	-529	-81	-14	-23	189174	37864	-60	-14	-3484	-146
10	-1590	-200	-1013	-156	84	-33	137296	27526	-121	-32	-4204	208
11	-1358	-171	-865	-133	-41	-14	386024	77340	-72	-11	-9208	-731
12	-123	-15	-78	-12	-30	-12	19519	4309	-7	-3	-3046	-118
13	-309	-39	-197	-30	38	-8	71359	14324	-29	-9	735	149
14	-425	-54	-271	-42	-1959	-1197	1228876	246857	-732	-363	29128	6657
15	-12	-2	-8	-1	1035	499	88405	17596	251	131	5182	1081
16	-23	-3	-15	-2	104	48	19358	3863	22	12	742	192
17	-213	-27	-136	-21	-59	-98	251778	50530	-88	-40	7790	1686
18	-40	-5	-25	-4	-3	-1	12166	2432	-2	0	-312	-36
19	0	0	0	0	133	59	26497	5280	28	14	1485	342
20	2	0	1	0	379	216	-12026	-2418	121	63	-2092	-422
21	6	1	4	1	1516	705	146974	29422	346	180	10806	2259
22	-31	-4	-20	-3	139	63	37160	7454	29	16	1098	280
23	-66	-8	-42	-7	-1522	-788	9810	1981	-418	-216	-1241	-180
24	-119	-15	-76	-12	863	434	161125	32230	218	116	2254	436
25	-54	-7	-34	-5	-441	-218	46720	9427	-115	-58	-1482	-348
26	11	1	7	1	368	167	4186107	837254	81	42	50016	10087
27	-1	0	-1	0	356	61	-331196	-66240	-9	-5	9396	1865
28	-20	-3	-13	-2	160	89	-48658	-9747	48	25	-1216	-230
29	-441	-56	-281	-43	-110	-24	-360596	-72409	-24	-5	-11985	-2483
30	9	1	6	1	7	3	2746	552	1	1	240	44
31	0	0	0	0	-476	-253	22702	4542	-136	-71	774	159
32	-13	-2	-8	-1	-143	-74	98294	19651	-41	-20	805	175
33	-258	-32	-164	-25	334	52	233246	46769	-27	-8	13172	2919
34	20	3	13	2	-432	-211	-26602	-5315	-106	-56	-1504	-311
35	0	0	0	0	-11	-4	846	156	-1	-1	-257	-63
36	-1	0	0	0	0	0	1205	242	0	0	-8	4
37	-11	-1	-7	-1	-534	-124	-12172	-404	-14	3	-13882	-864
38	4	1	3	0	60	25	-48284	-9640	11	6	437	248
39	3	0	2	0	3	-9	-15418	-3155	-8	-5	1068	306
40	-23	-3	-15	-2	-856	-300	83502	17080	-111	-56	-13886	-2122
41	0	0	0	0	141	36	118384	23707	7	4	5609	1353
42	-3	0	-2	0	-155	-77	100793	20145	-40	-21	583	21
43	-21	-3	-14	-2	174	-5	369027	73710	-35	-17	13305	2246
44	-24	-3	-16	-2	1968	782	596577	118370	333	177	36028	10277
45	-1	0	0	0	72	32	40193	7978	15	8	1199	385
46	0	0	0	0	-243	-126	583	115	-66	-34	-165	-66
47	-3	0	-2	0	356	160	18348	3655	76	40	3005	697
48	-58	-7	-37	-6	-1133	-773	434973	87116	-471	-244	22684	3956
49	-7	-1	-4	-1	151	65	84445	16819	30	16	1486	-283
50	0	0	0	0	138	52	29836	5970	20	11	2576	586
51	-24	-3	-15	-2	335	98	249247	50080	26	16	11334	2780
52	-1802	-227	-1148	-177	4518	2126	1992418	402875	965	560	35557	11836
53	-1	0	0	0	182	43	332057	66436	6	3	9266	1928
54	4	0	2	0	318	192	-1023995	-204681	110	58	-14101	-2711
55	59	7	38	6	3074	823	3114979	622585	182	96	118683	24509
56	-1619	-204	-1032	-159	-3842	-1937	423919	85960	-1089	-531	-23693	-2293

Poll.→	19		20		21		22		23		24	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	-1040	-308	-266	-11	-22	-11	-42	-1	-1289	-161	-18	-9
2	-154	-45	-28	-2	-5	-2	-4	0	-191	-24	-4	-2
3	-56	-17	-12	-1	-1	0	-2	0	-76	-10	-1	0
4	7	1	31	1	5	3	5	0	-1	0	4	2
5	-1	0	-5	0	0	0	-1	0	0	-1	0	0
6	-13	-1	-32	-1	-2	-1	-5	0	2	0	-1	-1
7	3	0	2	0	0	0	0	0	0	0	0	0
8	-28	-1	40	1	-1	-1	6	0	2	0	-1	-1
9	-56	-17	-3	0	-2	-1	0	0	-69	-9	-1	-1
10	-80	-32	-4	0	-4	-2	-1	0	-131	-16	-3	-2
11	-82	-26	14	1	0	0	2	0	-102	-12	0	0
12	-3	-2	6	0	0	0	1	0	-10	-1	0	0
13	-20	-6	35	1	-1	-1	5	0	-23	-3	-1	0
14	-115	-29	114	5	-58	-30	18	0	-30	-3	-48	-25
15	21	6	5	0	21	11	1	0	-2	0	17	9
16	1	0	12	0	2	1	2	0	-2	0	2	1
17	-19	-7	-34	-1	-6	-3	-5	0	-23	-3	-5	-3
18	-3	-1	-1	0	0	0	0	0	-3	0	0	0
19	3	1	10	0	2	1	2	0	1	0	2	1
20	5	3	4	0	10	5	1	0	2	0	8	4
21	27	8	23	1	29	15	4	0	1	1	24	12
22	13	2	11	0	3	1	2	0	-3	0	2	1
23	11	-1	-6	0	-35	-18	-1	0	-9	-1	-29	-15
24	-29	2	-4	0	19	10	0	0	-11	-1	15	8
25	-7	-4	-12	-1	-10	-5	-2	0	-12	-2	-8	-4
26	24	2	57	2	7	4	9	0	4	1	6	3
27	-7	0	-5	0	-1	0	-1	0	-1	0	-1	0
28	0	1	-3	0	4	2	0	0	-6	-1	3	2
29	-41	-10	-12	-1	0	0	-2	0	-39	-7	0	0
30	2	0	-1	0	0	0	0	0	0	0	0	0
31	-7	-3	-4	0	-11	-6	-1	0	0	0	-9	-5
32	-4	-1	-53	-11	-7	-2	-5	0	-172	-23	-6	-3
33	-72	-5	15	1	-1	-1	2	0	-19	-2	-1	0
34	-2	-2	1	0	-9	-5	0	0	2	0	-7	-4
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0
37	16	5	-229	-6	-2	-1	-36	0	1	12	-1	-1
38	-1	0	-104	-4	1	0	-17	0	2	0	1	0
39	-2	0	-75	-3	-1	0	-12	0	1	0	-1	0
40	6	-1	-212	-7	-10	-5	-34	-1	-14	1	-8	-4
41	4	0	147	6	1	0	23	0	2	1	0	0
42	5	-1	-125	-4	-3	-2	-20	0	-1	0	-3	-1
43	17	0	885	31	-3	-1	141	2	-9	0	-2	-1
44	58	9	1273	46	28	15	203	4	-8	2	23	12
45	2	0	40	1	1	1	6	0	1	0	1	1
46	-3	-1	-5	0	-6	-3	-1	0	0	0	-5	-2
47	5	2	519	18	6	3	83	1	-2	0	5	3
48	-15	-10	906	33	-39	-21	144	2	0	2	-32	-17
49	6	1	139	5	3	1	22	0	-2	0	2	1
50	2	1	98	3	2	1	16	0	-1	0	1	1
51	21	2	265	10	2	1	42	1	-2	2	2	1
52	7	1	-553	-9	88	46	-88	1	-112	16	72	37
53	6	0	38	1	1	0	6	0	0	0	0	0
54	6	3	18	1	9	5	3	0	0	1	8	4
55	56	7	337	15	16	8	53	1	23	8	13	7
56	-119	-52	-3	-9	-88	-45	2	-1	-341	-39	-72	-37

Poll.→	25		26		27		28		29		30	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	-309321	-38974	177410	36702	-8	-4	-2	-1	944973	189034
2	0	0	-44051	-5551	11099	2394	-2	-1	-1	0	65935	13187
3	0	0	-16599	-2092	6835	1432	0	0	0	0	37774	7555
4	0	0	-261	-33	21507	4302	2	1	1	0	105664	21131
5	0	0	53	6	-1805	-361	0	0	0	0	-9248	-1849
6	0	0	-22	-3	-8064	-1612	-1	0	0	0	-40723	-8141
7	0	0	14	2	3091	618	0	0	0	0	15301	3060
8	0	0	-85	-11	10118	2026	-1	0	0	0	49406	9889
9	0	0	-16613	-2093	18834	3832	-1	0	0	0	96959	19393
10	0	0	-31830	-4011	13595	2842	-2	-1	0	0	70867	14164
11	0	0	-27183	-3425	38268	7760	0	0	0	0	197909	39580
12	0	0	-2461	-310	2017	413	0	0	0	0	10953	2189
13	0	0	-6177	-778	7413	1507	0	0	0	0	36628	7325
14	0	0	-8505	-1071	129159	25854	-22	-11	-4	-2	632406	126476
15	0	0	-243	-31	9543	1912	8	4	2	1	44725	8945
16	0	0	-469	-59	2046	411	1	0	0	0	9845	1969
17	0	0	-4258	-537	26756	5365	-2	-1	-1	0	129610	25918
18	0	0	-796	-100	1197	242	0	0	0	0	6220	1244
19	0	0	8	1	2848	570	1	1	0	0	13430	2686
20	0	0	37	5	-1484	-296	4	2	1	0	-6144	-1228
21	0	0	128	16	16254	3252	12	6	3	1	74984	14994
22	0	0	-625	-79	3884	779	1	1	0	0	18850	3769
23	0	0	-1331	-168	704	143	-14	-7	-3	-2	4318	866
24	0	0	-2390	-301	16662	3347	7	4	2	1	82344	16478
25	0	0	-1080	-136	4653	933	-4	-2	-1	0	24231	4845
26	0	0	219	28	430848	86162	3	2	1	0	2139347	427870
27	0	0	-25	-3	-32386	-6476	0	0	0	0	-169256	-33850
28	0	0	-401	-51	-5075	-1013	1	1	0	0	-24788	-4958
29	0	0	-8819	-1112	-37912	-7546	-1	-1	-1	-1	-183743	-36746
30	0	0	178	22	308	61	0	0	0	0	1400	280
31	0	0	-1	0	2396	478	-4	-2	-1	0	11586	2317
32	-3	0	-263	-33	10062	2013	-1	-1	0	0	50149	10030
33	0	0	-5162	-650	25326	5091	0	0	0	0	119103	23837
34	0	0	410	52	-2909	-585	-4	-2	-1	0	-13625	-2725
35	0	0	1	0	57	11	0	0	0	0	442	88
36	0	0	-11	-1	117	23	0	0	0	0	598	120
37	0	0	-220	-23	-3586	-718	7	7	5	5	-7690	-1541
38	0	0	85	11	-4865	-973	0	0	0	0	-24650	-4930
39	0	0	59	7	-1431	-286	-1	0	0	0	-7809	-1562
40	0	0	-467	-58	6523	1304	-2	0	0	1	42204	8438
41	0	0	-10	-1	12661	2532	0	0	0	0	60384	12076
42	0	0	-59	-7	10292	2058	-1	-1	0	0	51398	10278
43	0	0	-430	-54	39047	7809	-1	0	0	0	187783	37553
44	0	0	-485	-59	63811	12763	13	8	4	2	300693	60130
45	0	0	-15	-2	4153	831	1	0	0	0	20267	4053
46	0	0	-4	-1	41	8	-2	-1	0	0	296	59
47	0	0	-60	-8	2203	441	3	1	1	0	9222	1844
48	0	0	-1156	-146	47033	9405	-15	-7	-3	-1	221905	44379
49	0	0	-136	-17	8804	1761	1	1	0	0	42918	8583
50	0	0	-6	-1	3335	667	1	0	0	0	15199	3039
51	0	0	-481	-60	26483	5297	2	2	1	1	126535	25302
52	2	1	-36049	-4532	205209	41186	54	37	20	17	1013246	202634
53	0	0	-14	-2	34827	6965	0	0	0	0	169621	33923
54	0	0	72	9	-105668	-21131	4	2	1	1	-523431	-104688
55	1	0	1185	150	330365	66062	8	5	2	2	1589232	317842
56	-3	0	-32396	-4081	41444	8404	-32	-16	-6	-3	219032	43797

Poll.→	31		32		33		34		35		36	
Sec.	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	-4	-2	63486	12697	-1033	-14	23	-214	19282	3857	127	13
2	-1	-1	4386	877	-280	-4	-111	-69	961	192	2	0
3	0	0	2520	504	-128	-2	-2	-8	611	122	2	0
4	1	1	6995	1399	-66	-1	211	95	1250	250	0	0
5	0	0	-569	-114	20	0	11	3	260	52	0	0
6	0	0	-2560	-512	44	1	-28	-23	663	133	0	0
7	0	0	998	200	-4	0	9	4	53	11	0	0
8	0	0	3312	662	21	0	-8	-15	913	183	0	0
9	0	0	6408	1282	-168	-2	-8	-17	1074	213	4	0
10	-1	0	5189	1038	-159	-2	72	-22	5082	1017	0	0
11	0	0	12767	2553	-2337	-33	-31	-10	-516	-99	3	0
12	0	0	677	135	-4319	-60	-23	-9	-281	-55	0	0
13	0	0	2590	518	-107	-1	32	-5	1830	366	0	0
14	-12	-6	42354	8471	-1029	-14	-1396	-864	11659	2332	11	1
15	5	2	3216	643	-101	-1	757	363	2688	538	0	0
16	0	0	689	138	-13	0	77	35	437	87	0	0
17	-1	-1	8920	1784	-582	-8	-33	-69	4423	885	1	0
18	0	0	396	79	-8	0	-2	0	-61	-12	0	0
19	1	0	954	191	-5	0	98	43	707	141	0	0
20	2	1	-545	-109	43	1	272	156	-1244	-249	0	0
21	6	3	5522	1105	-96	-1	1112	514	5620	1124	0	0
22	1	0	1292	258	-127	-2	102	46	603	121	0	0
23	-7	-4	234	47	-259	-4	-1105	-571	-390	-78	0	0
24	4	2	5467	1094	-128	-2	629	315	1080	216	0	0
25	-2	-1	1476	295	-311	-4	-322	-158	-797	-159	0	0
26	2	1	138834	27767	-21	0	270	122	1614	323	0	0
27	0	0	-9998	-2000	14	0	276	48	8224	1645	0	0
28	1	0	-1645	-329	71	1	116	64	-331	-66	-2	0
29	-1	-1	-12174	-2435	55	1	-84	-17	-2263	-453	1	0
30	0	0	100	20	-2	0	5	2	81	16	0	0
31	-2	-1	791	158	-51	-1	-345	-184	341	68	0	0
32	-1	0	3242	648	-149	-2	-104	-54	-73	-14	0	0
33	0	0	8678	1736	-324	-5	260	41	8086	1617	1	0
34	-2	-1	-991	-198	149	2	-316	-154	-916	-183	0	0
35	0	0	10	2	1	0	-9	-3	-157	-31	0	0
36	0	0	37	7	-1	0	0	0	-15	-3	0	0
37	7	8	-1674	-335	-181	-3	-414	-99	-9948	-1990	0	0
38	0	0	-1545	-309	49	1	44	18	448	90	0	0
39	0	0	-426	-85	30	0	4	-6	677	135	0	0
40	0	1	1609	322	-325	-5	-643	-223	-9532	-1906	0	0
41	0	0	4208	842	-35	0	108	27	2502	500	0	0
42	-1	0	3303	661	-87	-1	-113	-56	-231	-46	0	0
43	0	0	12909	2582	-380	-5	140	-1	6279	1256	1	0
44	8	5	21401	4280	-545	-8	1461	571	16244	3249	1	0
45	0	0	1356	271	-15	0	53	23	366	73	0	0
46	-1	-1	10	2	-6	0	-176	-91	-78	-16	0	0
47	1	1	799	160	-44	-1	262	117	1706	341	0	0
48	-8	-4	15800	3160	-386	-5	-795	-555	12032	2406	0	0
49	1	0	2881	576	-86	-1	111	48	852	170	0	0
50	0	0	1145	229	-25	0	103	38	1353	271	0	0
51	2	2	8802	1760	-162	-2	253	72	5111	1022	1	0
52	38	29	67515	13503	-1461	-20	3299	1535	15704	3141	-2	0
53	0	0	11394	2279	-38	-1	140	33	3403	681	0	0
54	2	2	-34122	-6824	-37	-1	227	138	-1691	-338	0	0
55	5	4	109063	21813	-652	-9	2342	618	51451	10290	3	0
56	-17	-8	13687	2737	-17615	-247	-2797	-1408	-4283	-854	2	0

(45), crude petroleum (6), beverages (12), leather and leather product (23), drugs and medicine (32), gas and water supply (54), art silk, synthetic fiber textile (17), other non-metallic mineral product (37), metal product including hand tools (40) and other services (56), rubber (24). Thus, many highly polluting sectors have become negative contributor. The negative contribution has been very significant.

The sectors such as agriculture product (1), other services (56), drugs and medicine (32), plastic product (25), woolen textile (15), food product (11), dairy product (2), cotton textile (14), and art silk, synthetic fiber textile (17) have registered substantial increase in the quantity of biological oxygen demand (7). The 1993-94 technology has created 200 percent more quantity. The negative contributors include forestry (4), watches and clock (50), leather footwear (22), non-metallic mineral (8), batteries (45), wooden product (19), heavy chemical (28), other chemical (33), industrial machinery (42), cycle-rickshaw (49), electricity (53), agriculture implements (41), petroleum product (26), other non-metallic mineral product (37), rail equipment (47), paper product (20), non-electrical machinery (43), printing and publishing (21), miscellaneous manufacturing (51), rubber product (24), electrical and electronic equipment (44), construction (52) and transport services (55). These sectors have generated negative effect of around 128 percent with the 1993-94 technology.

Most of the sectors have shown negative trend for chemical oxygen demand (8). These sectors include transport services (55), construction (52), printing and publishing (21), paper product (20), electric and electronic equipment (44), miscellaneous manufacturing (51), rubber product (24), tobacco product (13), non-electrical machinery (43), petroleum product (26), electricity (53), hydrogenated oil (10), rail equipment (47), agriculture implements (41), wooden product (19), watches and clock (50), industrial machinery (42), non-ferrous basic metal (39), synthetic fiber, resin (34), non-metallic minerals (8), iron-steel (38), forestry (4), batteries (45), leather footwear (22), silk textile (16) and metallic mineral (7). For other pollutants also the same trend has been followed. As a result in the case of many pollutants the overall contribution has been negative.

During 1989-90 to 1993-94 the input technology has given improved results in terms of many important highly polluting sectors. Secondly, during this time period, the negative contribution has been very much significant and has led to the negative growth in the case of many pollutants. This implies that the situation has improved to some extent during the second sub-period of 1989-90 to 1993-94. Considerable number of highly polluting industries having high positive contribution during first sub-period have now started showing negative impact on pollution generation.

In the first sub-period, mostly other-services (56), construction (52), agriculture product (1) were seen in the case of almost every pollutant as a major contributor of pollution. Now during the second sub-period, other-services (56) sector has shown considerable negative impact in the case of most of the pollutants. The highly polluting sectors that were hardly showing any sign of improvement in input technology during the first sub-period have shown technological improvement during the second sub-period. This is evident from their negative contribution. However, there are certain sectors that were contributing positively with less magnitude that have now turned as major contributors. Transport services (55), dairy product (2), engineering sectors (40,43, 44, and 48), food product (11), hydrogenated oil (10), paper product (20), rubber product (24), plastic product (25) are some examples. In this way, there have been some sectors generating negative impact and some with positive impact. The overall effect has been the result of relative intensity of these two. The effect of technology on the pollution generation would be clear only when analysis is performed for the entire period. Now we cover entire period i.e. during 1983-84 to 1993-94 for the technological impact analysis.

The analysis covering entire period i.e. 1983-84 to 1993-94, the overall situation has not improved much. It is clear from table 5.6 that most of the industries have shown positive contribution during 1983-84 to 1993-94. Again construction (52), transport service (55), and other service (56) appear to be the most polluting. Other sectors such as dairy (2), sugar (9), hydrogenated oil (10), tobacco product (13), cotton textile (14), rubber (24), plastic (25), and other chemical (33) have also contributed substantially.

The important sectors showing negative growth of pollution are other livestock products (3), mining products (6,7,8), food products (11), synthetic fiber textile (17), leather (23), coal tar products (27), organic-inorganic heavy chemicals (28) and non-metallic mineral products (37). Now we will briefly look into the case of each pollutant and its generation for the period 1983-84 to 1993-94.

It is clear from the table that during 1983-84 to 1993-94, most of the pollutants have shown similar trend as of first sub-period. Again other services (56), agriculture product (1) and transport services (55) have become the major contributor in the generation of effluent quantity. Construction (52) and dairy product (2) have also indicated deterioration in input technology. The sectors that show negative growth of effluent quantity include— art silk, synthetic fiber textile (17), other livestock product (3), food product (11) and gas and water supply (54). Again, the effect of negative contribution has been less than the effect of other sectors showing positive contribution. As a result, the overall effect has been an increase in pollution because of change in technology over a period of time.

In the case of other pollutants also the same trend as of first sub-period has emerged. The difference is seen only in terms of magnitude of pollution change. In the analysis covering entire period the magnitude of pollution change has been slightly lower.

The production function approach followed in this chapter for technological assessment suggests that the technology has not been environment friendly over a period of time. It follows that the input usage in different sectors have generated more pollutants at the end of each time period. The reason responsible for the deterioration is possibly that over a period of time the prime objective has been to attain maximum growth of output. Thus, the selection of input technology was more a subject of economic output rather than pollution output. Over a period of time in the process of production inputs of the highly polluting nature have been used abundantly which has caused high pollution growth.

Table 5.6: **Sectoral Pattern of Change in Pollution Due to Change in Technology, 1983-84 to 1993-94**

Poll.→	1		2		3		4		5		6	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	128347	128299	142439	106451	464296	16266	9711	1526	5141	155	5124	855
2	61440	61429	63870	25712	160683	27077	10627	1528	3659	306	1112	193
3	-19252	-19248	-21461	-4374	-60922	-13307	-693	-136	-129	-23	278	45
4	9045	9043	8955	5426	21015	2465	4738	789	1145	90	653	123
5	178	178	214	172	465	58	44	9	6	0.209551	11	2
6	-173	-172	-442	-558	-2000	-237	24	-11	-70	-3	-99	-16
7	-60	-60	-257	-405	1300	85	101	22	12	0.420887	33	6
8	-227	-227	-238	-92	-1454	-138	-19	-9	-11	-0.427991	-28	-5
9	12958	12952	15304	9867	51837	3868	1452	229	453	19	559	94
10	13408	13407	11043	17837	-3803	-5602	3708	635	786	23	1398	237
11	-11288	-11290	-15455	-631	-3680	-11612	6456	1062	1910	59	2111	356
12	4198	4200	-10404	642	-16633	-392	409	93	-139	0.157169	236	40
13	23995	23991	21397	8265	22885	1699	3348	564	207	29	864	146
14	29965	29963	-18126	2173	46658	9838	4067	5635	-38919	-3939	24891	4074
15	3397	3397	1368	1813	1606	676	4332	705	325	20	1321	221
16	2985	2984	677	1099	11524	879	3566	643	-113	-28	1343	224
17	-19538	-19541	-42044	-36769	25026	-539	10214	1939	-2179	-228	5124	819
18	355	355	567	705	-387	-42	102	17	29	1	35	6
19	2416	2416	2122	1210	4923	539	1053	184	239	3	310	53
20	277	277	256	42	39	-3	-24	-4	-5	0	-10	-2
21	37958	37954	32398	8531	30993	3294	3064	630	515	24	811	166
22	5390	5390	5168	4601	3156	814	4725	922	207	-0.246342	1029	187
23	-1227	-1226	-1240	20	-7422	-134	5373	1066	26	-4	156	25
24	16406	16408	3919	5140	4138	-583	23284	3712	425	22	7462	1241
25	13002	13002	395	759	15450	3076	18036	3041	-1529	-8	5941	994
26	1620	1623	1442	2067	-18028	-448	-2303	-442	51	4	315	55
27	-30	-30	-59	-56	-267	-16	10	2	4	0.163237	5	1
28	-2724	-2725	326	2776	-3775	-588	-1141	-170	-392	-11	-773	-132
29	2230	2233	5273	7858	-28071	-1301	1379	292	-554	-4	-571	-96
30	375	375	428	234	1853	154	47	9	10	0.16133	16	3
31	1424	1423	1919	1031	11329	750	97	14	63	2	36	5
32	1823	1825	544	-352	-13203	-740	18	5	-24	-3	48	8
33	27765	27743	29572	20301	143121	9677	2513	304	-1133	-148	2101	346
34	4570	4571	-9962	-966	3105	2010	14491	2411	312	13	4946	840
35	-62	-61	-79	-51	-317	-25	-0.117032	-0.241103	-3	-0.119671	-3	-1
36	-182	-182	-265	-269	238	-17	92	14	64	1	31	5
37	-1013	-1015	-349	-171	11704	712	385	56	164	5	269	45
38	-932	-932	201	696	1528	-96	-406	-50	-213	-11	-238	-40
39	-1249	-1250	826	1437	4461	109	-396	-60	-237	-16	-216	-38
40	13718	13714	12600	8782	29206	3522	3321	547	728	37	899	150
41	362	363	1016	1229	-8945	-438	841	120	197	11	281	46
42	41	41	1556	979	4850	441	1481	228	292	19	446	73
43	13112	13106	15547	10660	52363	4983	7681	1234	1941	67	2328	383
44	18600	18597	12570	8253	41300	5196	17052	2822	5586	97	5365	887
45	1651	1653	-748	-150	-13266	-438	2943	486	585	12	941	158
46	980	979	1315	517	6990	460	290	56	66	3	95	21
47	8793	8793	5992	4660	8164	1647	3233	557	311	9	991	170
48	6555	6556	11458	11395	-1792	208	8152	1354	537	21	2961	502
49	148	148	881	581	-2460	-280	1114	172	286	8	371	60
50	420	420	324	192	-598	24	121	16	36	3	33	5
51	-2897	-2902	-1926	-1021	35197	1676	3894	578	875	15	1591	267
52	107048	107023	110094	75875	244364	30846	44944	7499	10775	292	13775	2277
53	-900	-900	-3379	-4857	7321	188	1410	241	230	8	516	87
54	-8902	-8900	-13246	-12900	-11964	-2079	-133	-28	33	0.116408	75	14
55	123333	123325	138517	115070	114417	29669	25583	4119	8175	162	9202	1548
56	507438	507361	535237	223096	749049	85660	128782	21013	22562	1311	32875	5601

BT- Before Treatment values, AT- After treatment values. For sectors and pollutants specificantion, see appendices 3.1 and 3.2.

Poll.→	7		8		9		10		11		12	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	324129	4085	756673	15243	31861	2022	26210	3346	0	0	22	1
2	99104	2428	237237	10624	12475	782	7898	958	0	0	5	0
3	-34947	-843	-82664	-3229	-6033	-213	-3136	-379	0	0	1	0
4	19894	372	47990	1992	276	110	572	37	0	0	2	0
5	449	6	1082	34	5	3	4	0	0	0	0	0
6	-1345	-2	-2997	-30	8	3	61	5	0	0	0	0
7	1370	18	3232	35	-2	-6	10	1	0	0	0	0
8	-1440	-17	-3475	-71	-7	-2	10	1	0	0	0	0
9	45464	502	107521	2396	1701	169	1357	163	0	0	2	0
10	5623	62	18125	2876	-3976	207	-1224	-119	0	0	4	0
11	60	-73	349	-2812	-1095	16	469	85	-12	-1	9	0
12	-18523	-36	-21679	1277	126	14	-229	4	0	0	1	0
13	29559	751	77684	6843	-62	139	158	-2	0	0	3	0
14	32616	4183	84711	6728	1394	-229	1412	163	0	0	20	1
15	-2034	202	-4410	723	-29	15	8	0	0	0	1	0
16	9353	234	24206	920	-215	7	-9	-10	0	0	1	0
17	19361	952	44676	-2319	-82	-570	244	32	0	0	4	0
18	-129	-2	-247	61	-59	8	-34	-5	0	0	0	0
19	4451	109	10969	593	34	19	60	3	0	0	0	0
20	180	6	529	90	-3	1	-1	0	0	0	0	0
21	38591	1132	104697	11442	318	129	312	24	0	0	3	0
22	50	242	837	1057	40	80	108	4	0	0	-3	0
23	-13233	-87	-30007	-222	-238	-12	-118	-15	0	0	0	0
24	-10137	1291	-19838	3784	-121	72	-140	-13	0	0	-36	-2
25	7065	1187	19496	3388	80	9	46	5	0	0	1	0
26	-22465	-64	-52153	52	41	26	-24	-23	0	0	1	0
27	-311	-1	-739	-5	0	-1	0	0	0	0	0	0
28	1757	-282	2863	-743	-714	0	-496	-54	0	0	-1	0
29	-22185	-289	-52127	-9	-840	116	-655	-71	0	0	-1	0
30	1692	17	4025	83	46	4	28	4	0	0	0	0
31	12058	87	28765	405	41	15	18	2	0	0	0	0
32	-13475	56	-29923	407	93	43	-7	0	0	0	0	0
33	151188	1405	365027	7178	-70	287	239	36	0	0	3	0
34	-9794	773	-15194	869	213	-3	89	15	0	0	1	0
35	-323	-3	-776	-16	-1	-1	0	0	0	0	0	0
36	141	4	299	-14	-9	-5	-21	-1	0	0	0	0
37	11228	73	26205	-48	21	-9	-347	-14	0	0	1	0
38	2661	-58	6343	-198	-17	10	-384	-14	0	0	-1	0
39	5700	-59	13341	-211	-23	16	-624	-23	0	0	-1	0
40	28003	489	67504	2501	292	156	1811	75	0	0	3	0
41	-10919	-27	-25462	110	22	18	-828	-30	0	0	-1	0
42	3583	71	8845	384	30	10	-1483	-53	0	0	1	0
43	47599	732	114255	3378	287	152	-1527	-47	0	0	5	0
44	23762	1225	58686	4192	337	134	61	11	0	0	4	0
45	-17537	93	-41360	168	44	5	237	10	0	0	-1	0
46	7359	74	17655	365	27	9	-115	-3	0	0	0	0
47	6084	319	15011	1450	133	80	1922	71	0	0	1	0
48	-10846	377	-22298	1975	256	183	-5050	-181	0	0	-14	-1
49	-3971	32	-8820	243	22	10	-1023	-36	0	0	-2	0
50	-799	9	-1841	82	8	3	55	2	0	0	0	0
51	32779	315	76487	34	-80	-49	-1579	-59	0	0	-2	0
52	205305	4732	496349	23193	3526	1286	1469	263	0	0	36	2
53	7212	186	17227	319	-13	-66	-8	1	0	0	1	0
54	-11496	-38	-28562	-1275	-180	-192	-55	-3	0	0	0	0
55	73454	3100	195964	22889	3445	1876	461	85	0	0	71	3
56	756383	23391	1839129	118946	16374	6992	19319	1073	0	0	36	2

Poll.→ Sec.↓	13 BT	13 AT	14 BT	14 AT	15 BT	15 AT	16 BT	16 AT	17 BT	17 AT	18 BT	18 AT
1	7064	890	4501	693	-8	-4	11717	785	342	43	62589	8117
2	1889	238	1204	185	419	218	2964	265	210	72	16766	2204
3	-734	-93	-468	-72	-82	-43	-541	-73	-59	-16	-6435	-827
4	25	3	16	2	816	425	432	29	226	117	320	97
5	0	0	0	0	2	1	4	0	1	0	5	2
6	-3	0	-2	0	50	26	-36	-1	15	7	-51	-17
7	1	0	1	0	5	3	9	0	2	1	15	5
8	-1	0	-1	0	-7	-4	-7	0	-2	-1	-14	0
9	342	43	218	34	36	19	670	43	26	7	3107	430
10	-189	-24	-121	-19	237	124	448	-4	56	33	-1535	-154
11	219	28	139	21	203	106	1283	48	66	31	2011	322
12	29	4	19	3	19	10	-962	-9	1	3	-660	33
13	-22	-3	-14	-2	95	50	83	9	25	14	30	149
14	386	49	246	38	-4682	-2440	-7933	-835	-1290	-672	3557	482
15	3	0	2	0	44	23	141	8	12	6	39	13
16	-28	-3	-18	-3	9	5	32	-8	1	1	-194	6
17	108	14	69	11	-2098	-1094	-481	-42	-574	-301	839	131
18	-11	-1	-7	-1	1	1	5	-1	0	0	-87	-7
19	3	0	2	0	82	43	147	3	23	12	61	35
20	-1	0	-1	0	6	3	-2	0	2	1	-7	-2
21	34	4	22	3	1793	935	271	10	496	258	305	8
22	-1	0	0	0	928	483	555	82	256	133	80	52
23	-27	-3	-17	-3	-86	-45	1355	267	-25	-12	-224	-17
24	-12	-1	-7	-1	-198	-103	341	40	-56	-28	-142	-1
25	17	2	11	2	158	82	-912	-2	44	23	115	8
26	10	1	7	1	148	77	45	3	41	21	150	42
27	0	0	0	0	1	1	2	0	0	0	3	1
28	-142	-18	-91	-14	-165	-86	-361	-18	-53	-25	-1239	-132
29	-207	-26	-132	-20	-56	-29	-494	-22	-25	-9	-1853	-252
30	9	1	6	1	-3	-2	26	1	0	0	79	9
31	5	1	3	1	-41	-21	41	1	-11	-6	50	6
32	2	0	1	0	-24	-12	-4	-1	-7	-3	-3	-15
33	97	12	62	10	-276	-144	-44	-23	-73	-39	602	-17
34	49	6	31	5	902	470	-185	4	251	130	49	60
35	0	0	0	0	-5	-2	-2	0	-1	-1	0	1
36	0	0	0	0	0	0	32	0	0	0	-5	-2
37	9	1	6	1	20	11	88	3	0	3	121	40
38	-7	-1	-5	-1	-1	0	-125	-5	0	0	58	128
39	-8	-1	-5	-1	-127	-66	-126	-7	-36	-18	-613	-535
40	23	3	14	2	11	6	440	20	5	2	1327	1108
41	3	0	2	0	-23	-12	70	4	-6	-3	54	24
42	7	1	4	1	-78	-40	89	6	-21	-11	-60	-127
43	33	4	21	3	-319	-167	1019	32	-86	-46	256	-67
44	45	6	29	4	-458	-239	3179	50	-124	-65	587	180
45	8	1	5	1	82	43	338	6	22	12	206	136
46	3	0	2	0	276	144	36	2	76	40	21	-13
47	8	1	5	1	276	144	236	7	77	40	146	68
48	21	3	13	2	472	246	161	4	130	68	38	-173
49	4	0	2	0	-95	-50	134	4	-26	-14	-12	-49
50	1	0	1	0	-3	-2	17	2	-1	0	-31	-43
51	11	1	7	1	73	38	428	0	13	10	-316	-399
52	448	56	285	44	-1229	-638	6626	175	-403	-173	4594	621
53	10	1	6	1	34	18	136	5	10	5	115	20
54	3	0	2	0	71	37	26	1	19	10	26	-3
55	307	39	196	30	762	397	4825	109	224	111	3063	638
56	1190	150	758	117	6822	3557	18611	903	1937	989	21058	5104

Poll.→	19		20		21		22		23		24	
Sec.↓	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	561	140	-151	-4	0	0	-25	0	582	75	0	0
2	156	41	93	6	11	5	14	0	198	25	9	4
3	-54	-15	-44	-2	-2	-1	-7	0	-73	-9	-2	-1
4	22	6	77	3	19	10	12	0	9	1	16	8
5	0	0	0	0	0	0	0	0	0	0	0	0
6	-6	0	10	0	1	1	2	0	3	0	1	1
7	1	0	1	0	0	0	0	0	0	0	0	0
8	-2	0	2	0	0	0	0	0	0	0	0	0
9	30	7	9	0	1	0	1	0	28	4	1	0
10	3	-2	-80	-3	5	3	-13	0	-18	-2	5	2
11	35	6	-54	-1	5	2	-9	0	33	4	4	2
12	9	1	-21	-1	0	0	-3	0	2	0	0	0
13	7	0	43	2	2	1	7	0	5	1	2	1
14	-86	-28	-1	-1	-109	-57	-1	-1	11	2	-89	-47
15	3	0	0	0	1	1	0	0	-3	0	1	0
16	0	-1	18	1	0	0	3	0	-3	0	0	0
17	-8	-11	-13	-1	-49	-25	-3	0	4	1	-40	-21
18	0	0	1	0	0	0	0	0	-1	0	0	0
19	3	1	8	0	2	1	1	0	1	0	2	1
20	0	0	0	0	0	0	0	0	0	0	0	0
21	38	12	31	1	42	22	5	0	6	1	34	18
22	31	8	20	1	22	11	3	0	3	0	18	9
23	36	7	-1	0	-2	-1	0	0	-4	0	-2	-1
24	-24	0	-9	0	-5	-2	-1	0	-3	0	-4	-2
25	9	1	0	0	4	2	0	0	0	0	3	2
26	13	1	16	0	3	2	3	0	-7	0	3	1
27	0	0	0	0	0	0	0	0	0	0	0	0
28	-18	-4	-3	0	-4	-2	0	0	-16	-2	-3	-2
29	-23	-4	1	0	-1	-1	0	0	-10	-2	-1	-1
30	1	0	-1	0	0	0	0	0	1	0	0	0
31	0	0	0	0	-1	0	0	0	1	0	-1	0
32	0	0	1	1	0	0	0	0	10	1	0	0
33	-49	0	-15	0	-6	-3	-3	0	11	2	-5	-3
34	15	6	5	0	21	11	1	0	3	1	17	9
35	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	-3	0	0	0	-1	0	0	0	0	0
37	4	0	-64	-2	0	0	-10	0	-1	0	0	0
38	-3	0	-67	-3	0	0	-11	0	0	0	0	0
39	-8	-1	-110	-4	-3	-2	-18	0	0	0	-2	-1
40	11	1	309	12	0	0	49	1	7	1	0	0
41	1	0	-148	-5	-1	0	-24	0	-1	0	0	0
42	3	0	-268	-10	-2	-1	-43	-1	-1	0	-1	-1
43	14	-1	-291	-10	-7	-4	-46	-1	1	0	-6	-3
44	24	-1	-12	0	-11	-6	-2	0	3	1	-9	-5
45	3	1	38	1	2	1	6	0	1	0	2	1
46	4	2	-22	-1	6	3	-4	0	1	0	5	3
47	7	2	337	12	6	3	54	1	3	0	5	3
48	16	3	-903	-32	11	6	-144	-2	1	0	9	5
49	0	0	-184	-6	-2	-1	-29	-1	0	0	-2	-1
50	0	0	9	0	0	0	1	0	0	0	0	0
51	-3	1	-282	-10	1	1	-45	-1	-7	-1	1	1
52	113	4	-39	8	-29	-15	-8	0	59	8	-23	-12
53	6	0	-5	0	1	0	-1	0	2	0	1	0
54	2	0	-9	0	2	1	-1	0	0	0	1	1
55	66	12	-86	-1	18	9	-14	0	45	7	15	8
56	378	78	2577	137	174	85	395	10	894	119	143	73

Poll.→ Sec.↓	25		26		27		28		29		30	
	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	1	0	141375	17813	7619	956	0	0	0	0	768	205
2	1	0	37807	4764	2038	257	4	2	1	0	86	21
3	0	0	-14696	-1852	-790	-100	-1	0	0	0	-5	-1
4	0	0	492	62	38	7	7	4	2	1	15	1
5	0	0	7	1	1	0	0	0	0	0	1	0
6	0	0	-55	-7	-6	0	0	0	0	0	-10	0
7	0	0	21	3	2	0	0	0	0	0	2	0
8	0	0	-27	-3	-2	0	0	0	0	0	-3	0
9	0	0	6853	863	370	47	0	0	0	0	35	9
10	0	0	-3786	-477	-195	-24	2	1	0	0	46	9
11	0	0	4377	551	244	31	2	1	0	0	51	9
12	0	0	590	74	35	4	0	0	0	0	13	1
13	0	0	-447	-56	-20	-3	1	0	0	0	14	1
14	0	0	7721	973	393	32	-43	-22	-9	-5	79	7
15	0	0	58	7	4	1	0	0	0	0	3	0
16	0	0	-551	-69	-28	-4	0	0	0	0	3	0
17	0	0	2166	273	106	6	-19	-10	-4	-2	24	0
18	0	0	-214	-27	-11	-1	0	0	0	0	1	0
19	0	0	56	7	4	1	1	0	0	0	2	0
20	0	0	-16	-2	-1	0	0	0	0	0	0	0
21	0	0	688	87	59	13	16	9	3	2	26	2
22	0	0	-10	-1	11	4	8	4	2	1	14	1
23	0	0	-547	-69	-31	-4	-1	0	0	0	-2	0
24	0	0	-231	-29	-28	-3	-2	-1	0	0	-39	0
25	0	0	334	42	22	3	1	1	0	0	11	0
26	0	0	210	26	18	2	1	1	0	0	16	0
27	0	0	4	1	0	0	0	0	0	0	0	0
28	0	0	-2847	-359	-157	-20	-2	-1	0	0	-19	-3
29	0	0	-4140	-522	-227	-28	-1	0	0	0	-15	-1
30	0	0	180	23	10	1	0	0	0	0	3	1
31	0	0	105	13	5	1	0	0	0	0	1	0
32	0	0	39	5	2	0	0	0	0	0	0	0
33	0	0	1950	246	77	12	-3	-1	-1	0	-67	1
34	0	0	973	123	60	11	8	4	2	1	5	1
35	0	0	-3	0	0	0	0	0	0	0	0	0
36	0	0	-9	-1	0	0	0	0	0	0	0	0
37	0	0	189	24	12	1	0	0	0	0	5	0
38	0	0	-143	-18	-9	-1	0	0	0	0	-4	0
39	0	0	-163	-21	-12	-2	-1	-1	0	0	-8	0
40	0	0	455	58	29	3	0	0	0	0	13	0
41	0	0	65	8	3	0	0	0	0	0	0	0
42	0	0	136	17	8	1	-1	0	0	0	5	0
43	0	0	669	84	39	3	-3	-2	-1	0	19	1
44	0	0	909	115	56	4	-4	-2	-1	0	35	1
45	0	0	166	21	10	1	1	0	0	0	3	0
46	0	0	69	9	6	2	3	1	1	0	2	0
47	0	0	169	21	13	2	3	1	1	0	5	0
48	0	0	414	52	30	5	4	2	1	0	15	1
49	0	0	78	10	4	0	-1	0	0	0	1	0
50	0	0	24	3	1	0	0	0	0	0	0	0
51	0	0	221	28	10	2	1	0	0	C	-5	0
52	1	0	8961	1129	514	56	-11	-6	-3	-1	170	14
53	0	0	197	25	13	2	0	0	0	0	8	0
54	0	0	67	8	5	1	1	0	0	0	1	0
55	1	0	6153	775	351	45	7	4	1	1	58	5
56	17	2	23823	3003	1404	192	62	32	13	7	272	26

Poll.→	31		32		33		34		35		36	
Sec.	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT	BT	AT
1	0	0	0	0	422	6	-6	-3	1	0	196	20
2	2	1	0	0	194	3	304	158	0	0	20	2
3	0	0	0	0	22	0	-60	-31	-1	0	-1	0
4	4	2	0	0	48	1	592	308	0	0	0	0
5	0	0	0	0	1	0	2	1	0	0	0	0
6	0	0	0	0	-5	0	36	19	0	0	0	0
7	0	0	0	0	2	0	4	2	0	0	0	0
8	0	0	0	0	-2	0	-5	-3	0	0	0	0
9	0	0	0	0	104	1	26	13	3	0	8	1
10	1	1	0	0	87	1	172	90	1	0	8	1
11	1	1	0	0	-34	0	147	77	-93	-6	8	1
12	0	0	0	0	-2188	-31	14	7	-3	0	1	0
13	0	0	0	0	93	1	69	36	-1	0	1	0
14	-23	-12	-2	-1	135	2	-3395	-1770	-1	0	9	1
15	0	0	0	0	3	0	32	17	0	0	0	0
16	0	0	0	0	16	0	7	3	0	0	0	0
17	-10	-5	-1	0	-341	-5	-1522	-793	0	0	2	0
18	0	0	0	0	3	0	1	0	0	0	0	0
19	0	0	0	0	7	0	59	31	0	0	0	0
20	0	0	0	0	2	0	4	2	0	0	0	0
21	9	5	1	0	23	0	1300	678	0	0	0	0
22	5	2	0	0	42	1	673	351	0	0	0	0
23	0	0	0	0	8	0	-62	-32	0	0	0	0
24	-1	-1	0	0	-19	0	-144	-75	0	0	0	0
25	1	0	0	0	-74	-1	114	60	0	0	0	0
26	1	0	0	0	23	0	107	56	0	0	0	0
27	0	0	0	0	0	0	1	0	0	0	0	0
28	-1	0	0	0	-15	0	-120	-63	0	0	-3	0
29	0	0	0	0	-11	0	-40	-21	0	0	-1	0
30	0	0	0	0	0	0	-2	-1	0	0	1	0
31	0	0	0	0	6	0	-30	-16	0	0	0	0
32	0	0	0	0	-8	0	-17	-9	0	0	0	0
33	-1	-1	0	0	-102	-1	-200	-104	0	0	2	0
34	4	2	0	0	-904	-13	654	341	0	0	0	0
35	0	0	0	0	0	0	-3	-2	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	10	0	15	8	0	0	0	0
38	0	0	0	0	-26	0	-1	0	0	0	0	0
39	-1	0	0	0	-17	0	-92	-48	0	0	0	0
40	0	0	0	0	73	1	7	4	0	0	0	0
41	0	0	0	0	12	0	-17	-9	0	0	0	0
42	0	0	0	0	24	0	-56	-29	0	0	0	0
43	-2	-1	0	0	112	2	-232	-121	0	0	1	0
44	-2	-1	0	0	51	1	-332	-173	0	0	1	0
45	0	0	0	0	9	0	60	31	0	0	0	0
46	1	1	0	0	15	0	200	104	0	0	0	0
47	1	1	0	0	21	0	200	104	0	0	0	0
48	2	1	0	0	90	1	342	178	0	0	0	0
49	0	0	0	0	14	0	-69	-36	0	0	0	0
50	0	0	0	0	4	0	-2	-1	0	0	0	0
51	0	0	0	0	12	0	53	28	0	0	0	0
52	-6	-3	0	0	931	13	-888	-463	-1	0	13	1
53	0	0	0	0	28	0	25	13	0	0	0	0
54	0	0	0	0	7	0	51	27	0	0	0	0
55	4	2	0	0	54	1	552	288	0	0	4	0
56	34	18	3	1	15546	218	4946	2578	-3	0	18	2

5.3 Summary

In this chapter, we have analyzed the role of technology in pollution generation during 1983-84 to 1993-94. For this purpose three $I-O$ tables for the year 1983-84, 1989-90 and 1993-94 have been utilized. The analysis is done by changing the input coefficient matrix alone while the final demand vector is kept constant at the base year. The technology is reflected by the input coefficient matrix. The analysis is performed for aggregated as well as at disaggregated level for 36 water pollution parameters of the 56 sectors of the $I-O$ table. The entire period has been divided into two sub-periods viz. 1983-84 to 1989-90 and 1989-90 to 1993-94. A separate analysis covering entire period i.e. 1983-84 to 1993-94, has also been done.

The results of this chapter indicates that over a period of time the input technology has not been environment friendly. Even in the case of highly polluting sectors there has been high pollution growth. As we have seen in the preceeding chapter, most of the pollution generation has been from the highly polluting sectors. Thus, aim of the policy should be to curb the pollution from these sectors. The technology deterioration was more prominent during the first sub-period. During second sub-period some improvement has been observed in terms of input technology. The analysis covering entire period of 1983-84 to 1993-94 again indicates deterioration in technology over a period of time.

During the first sub-period, highest growth has been observed for agriculture (1) and other services (56) sectors. During this time period agriculture sector was mechanized more and more, that in turn has generated more indirect effects. The high rate of pollution in service sector is because of the increase in the growth of this sector during this time period. The dairy (2) and construction (52) have also shown significant high growth of pollution over a period of time. Dairy industry is among the highly polluting industries and in the last chapter we have seen that it is a cause of concern because of its direct effects. Thus, environmentally sound technology is needed to reduce the direct water pollution intensity of this sector. The high contribution of

construction sector is due to its high multiplier effect which has caused more indirect effects and generated high pollution output. Other industries such as sugar (9), edible oil (10), food products (11), beverages (12), tobacco (13), textile (14 to 16), jute (18), leather (22, 23), rubber (24), plastic (25), fertilizers (29), paints and varnishes (31), drugs and medicines (32), other chemicals (33), synthetic fiber (34), batteries (45) have also shown positive growth of pollution. Thus, in most of the industries, substantial increase in pollution has been observed over a period of time.

The negative pollution growth has been shown by very few industries. Most important among them are livestock product (3), synthetic textile (17), paper (20), petroleum product (26), iron and steel (38) and electricity (52). Other industries such as mining, cement, industrial machinery and transport equipment have also shown negative trend in few instances. Although some sectors have shown improvement by registering the negative value of pollution output, the negative impact of the sectors have always been less than the positive effect. Consequently, over a period of time technology has caused more pollutants.

During 1989-90 to 1993-94, considerable number of highly polluting industries have started showing negative growth of pollution. The industries such as sugar, beverages, textile, leather, petroleum product, fertilizer, drugs medicine, iron steel have shown declining trend in pollution generation. The highest positive growth of pollution is seen in transport services and construction. But construction sector has shown sign of improvement for some of the pollutants. Other services sector has shown maximum improvement.

For the entire period 1983-84 to 1993-94 the situation is very much similar to that of first sub-period. Again construction, transport service, and other services appear to be most polluting.

In the present analysis the production function approach used for the analysis has not produced very satisfactory results. The analysis shows that over a period of time the input profile of industries has generated more pollutants.

Chapter 6

Industrial Effluents, Abatement Techniques and Status of Pollution Abatement

It has been widely accepted that residual flows are present in the form of joint products of consumption and production process and these are discharged to the different environmental media. Effluents generated by industry can be either discharged to the public foul sewer or directly to a watercourse. In both cases there are discharge consent conditions determined by the regulatory authority, which often requires treatment of effluents to meet them. The volume and quality of the effluent being discharged to the foul sewer primarily determines the discharge costs. Alternatively, in some cases the effluents can be treated to a quality which will allow direct recycle and reuse and/or occasionally the recovery of valuable by-products.

For a process production a particular treatment alternative thus depends upon volume, quality and cost implications of effluent treatment. Depending upon the nature of the industry and the projected uses of the waters of the receiving stream, various waste constituents have to be removed and accordingly abatement alternative should be chosen. Treatment of industrial wastes is done at three stages, namely primary, sec-

ondary and tertiary treatment. For some wastes primary treatment only is sufficient. Most of the wastes require secondary treatment also. Still other effluents require tertiary treatment. The primary treatment is employed to remove suspended solids, and to certain extent color and to bring the pH in the natural range. Secondary treatment is the biological process applied to reduce biological oxygen demand (BOD) and chemical oxygen demand (COD). Tertiary treatment is performed for further purification and color removal. In most of the industries we find tertiary treatment, a rare practice. For all abatement alternatives, cost consideration is an important factor. This cost varies for each industry depending upon the volume and concentration of the effluent.

The main objective of this chapter is to examine the status of pollution abatement in the economy. For this purpose, effects of three alternative abatement techniques have been analyzed and compared with the actual intensity results of all the sectors. Mainly first two abatement techniques are taken as an alternate of secondary treatment and the third technique indicates tertiary level treatment. The three alternatives have been arranged in such a manner so that the first alternate is least efficient and the third one is most efficient.

This chapter has been divided into three parts. In section 6.1, the methodology has been discussed for the assessment of pollution control status in India. In the next section of 6.2 results are discussed. Finally, in section 6.3 summary of the chapter is presented.

6.1 Methodology

In this chapter we propose to analyze the magnitude of after abatement pollution generation when different abatement techniques are adopted. Three alternative abatement techniques are suggested for the analysis. These are arranged in descending order of efficiency in abatement, thus, first technique is most cost effective but abate comparatively less pollutants than the second and third abatement techniques. The methodology for

assessing the impact of pollution abatement techniques has essentially been same as described in chapter 2. The 'open, static Leontief' type model is applied here as well to study the differences in pollution generation from the three abatement techniques. The total direct plus indirect pollution generation is explained by the following equation–

$$A_{21}(I - A_{11})^{-1}Y_k \tag{6.1}$$

where, A_{21} in equation (6.1) matrix shows the direct pollution coefficient matrix, A_{11} is the usual matrix of inter-industry coefficients and Y_k is the final demand vector. This is the same relationship as given in equation (2.40) of chapter 2.

Equation (6.1) is repeatedly being used for the determination of the level of pollution generation with the first, second and the third abatement techniques. The theoretical data on three abatement techniques, described in various policy documents of Central Pollution Control Board (CPCB), has been used for this purpose. Thus, the three different levels of pollution output presents an ideal situation which states the status of pollution when three techniques are adopted one by one. These three levels are then compared with each other to find out the efficiency of each technique in comparison to the others. In the next step we have compared the actual 'after abatement' results of pollution output and direct-indirect pollution intensity (chapter 4) with the level of pollution output of three abatement techniques. Actual pollution intensity has already been discussed in detail in chapter 4. The 'after abatement' results obtained in chapter 4 are based on the data that is collected from different industrial groups and hence, are the indicators of the actual status of industrial pollution. The comparison of this kind will reveal that how far actual pollution intensity has deviated/exceeded the pollution intensity of three techniques.

Although theoretical data has been used for this purpose, the data limitation for this analysis has been severe. The data on three abatement techniques could be obtained only for 12 sectors of the input-output table. These sectors include other livestock products (3), sugar (9), food products (11), beverages (12), art silk, synthetic fiber textile (17), jute textile (18), paper and paper based products (20), petroleum

products (26), pesticides (30), paint varnishes and lacquer (31), drugs and medicines (32) and other chemicals (33). All these sectors fall under the highly polluting category. The 'after abatement' data on remaining sectors is taken from the actual pollution matrix, that is, used in chapter 4.

Thus, the results given in this chapter should be analyzed under the fact that the resulting change is the reflection of only 12 sectors mentioned earlier. Thus, even a small change in pollution intensity is meaningful; because better results can always be obtained if pollution matrix is revised to include all the sectors of the input-output table. The analysis has been performed for five water pollution parameters namely, effluent quantity, suspended solids, BOD, COD and oil and greases. This has been done because most abatement techniques target to abate these pollutants only. In all over the analysis effluent quantity has not varied from technique to technique. This is because of the unavailability of data on effluent quantity. It is therefore, assumed in this analysis that even after abatement the effluent quantity does not change. It is only the composition that changes. As we have mentioned in earlier chapters that there are sufficient evidences available to support this argument. Effluent quantity has been included in this analysis because it is the most important water pollution indicator. In the next section results are summarized in detail.

6.2 Results and Discussion

As mentioned above that the effect of three abatement techniques has been considered for the analysis. This has been done for all the years under consideration i.e. 1983-84, 1989-90 and 1993-94. The following analysis attempts to examine two main objectives. Firstly, the efficiency of each abatement technique in comparison to the others. Secondly, to find out the status of pollution abatement by way of comparing the results on pollution intensity, derived from the three techniques with that of actual intensity results. For this purpose results are calculated for 'direct plus indirect' pollution in-

tensity as well as for 'aggregate pollution' output. The results obtained from the three techniques are compared with the actual after abatement pollution results analyzed in chapter 4.

6.2.1 The Direct and Indirect Effects of Different Techniques

All the results related with direct-indirect pollution intensity of all three abatement techniques are shown in table 6.1. The sectors are specified in rows and abatement techniques along with pollutants appear in columns. As is clear from the table that not much differences are seen in the pollution intensity of all the three techniques. Some significant changes can be observed only in the case of BOD and COD. The third technique has produced around 7-10% lower intensity for the sectors such as, synthetic fiber, resin (34), art silk synthetic textile (17), plastic products (25), petroleum products (26), beverages (12), woolen textile (19), paper products (20). In the case of other sectors too differences in the pollution intensity of three techniques can be observed, but the differences are not very significant. Similar trend has been observed in the case of COD.

Thus, we find that results obtained from the three abatement techniques produce almost similar results. In the case of some of the highly polluting sectors third technique can be regarded comparatively efficient. The similar results for the three techniques are found because of the data limitations. We have already mentioned that actual data for three abatement techniques could be obtained only for 12 sectors. Thus, results of this chapter must be evaluated in that light. At least, this analysis implies that if it is possible to get the data on highly polluting sectors, then of course tertiary level treatment can reduce the pollution intensity and problem can be solved upto some extent. The differences that can be observed among the three techniques, are only because of the interaction effect of the 12 sectors. We can always expect better results if pollution matrix can be revised for all the sectors.

The objective of this chapter is not to establish the superiority of one technique

Table 6.1: **Direct Plus Indirect Pollution Intensity from Three Abatement Techniques, 1993-94.**

(Effluent quantity is in thousand cu.m. and other pollutants in tons)

	Effluent Quantity			Suspended Solids			BOD		
Tech.→ Sect.↓	I	II	III	I	II	III	I	II	III
1	0.09690	0.09690	0.09690	0.03072	0.03072	0.03071	0.00233	0.00226	0.00225
2	0.34856	0.34856	0.34856	0.05111	0.05110	0.05110	0.01311	0.01306	0.01306
3	0.15680	0.15680	0.15680	0.01052	0.01042	0.01040	0.00070	0.00065	0.00063
4	0.02263	0.02263	0.02263	0.00600	0.00599	0.00599	0.00025	0.00019	0.00018
5	2.42505	2.42505	2.42505	0.06921	0.06920	0.06920	0.00080	0.00063	0.00061
6	0.40856	0.40856	0.40856	0.01279	0.01278	0.01278	0.00029	0.00023	0.00022
7	0.11498	0.11498	0.11498	0.06025	0.06023	0.06023	0.00098	0.00085	0.00082
8	0.12350	0.12350	0.12350	0.02820	0.02819	0.02818	0.00286	0.00278	0.00277
9	0.11609	0.11609	0.11609	0.03327	0.03326	0.03324	0.00186	0.00175	0.00174
10	0.14241	0.14241	0.14241	0.05111	0.05111	0.05110	0.00410	0.00390	0.00389
11	0.16488	0.16488	0.16488	0.03707	0.03706	0.03703	0.00338	0.00312	0.00310
12	0.45781	0.45781	0.45781	0.29039	0.29038	0.29038	0.00234	0.00143	0.00127
13	0.16298	0.16298	0.16298	0.02869	0.02868	0.02868	0.00125	0.00103	0.00102
14	0.25575	0.25575	0.25575	0.07129	0.07127	0.07127	0.00574	0.00420	0.00418
15	0.23964	0.23964	0.23964	0.06264	0.06263	0.06261	0.00514	0.00329	0.00328
16	0.13574	0.13574	0.13574	0.03955	0.03954	0.03953	0.00220	0.00118	0.00116
17	0.61554	0.61554	0.61554	0.08357	0.08356	0.08356	0.00913	0.00278	0.00275
18	0.18000	0.18000	0.18000	0.07761	0.07759	0.07759	0.00141	0.00110	0.00108
19	0.07871	0.07871	0.07871	0.02538	0.02537	0.02537	0.00110	0.00054	0.00053
20	2.10338	2.10338	2.10338	0.10347	0.10344	0.10343	0.00415	0.00366	0.00364
21	0.58873	0.58873	0.58873	0.05911	0.05909	0.05909	0.00199	0.00167	0.00165
22	0.12927	0.12927	0.12927	0.05103	0.05102	0.05102	0.00366	0.00294	0.00293
23	0.15696	0.15696	0.15696	0.09238	0.09237	0.09237	0.01038	0.00986	0.00985
24	0.36534	0.36534	0.36534	0.08403	0.08403	0.08402	0.01386	0.00755	0.00753
25	0.35557	0.35557	0.35557	0.07903	0.07901	0.07901	0.01792	0.00347	0.00345
26	0.34220	0.34220	0.34220	0.01998	0.01949	0.01941	0.00133	0.00110	0.00043
27	0.80364	0.80364	0.80364	0.06082	0.06080	0.06080	0.00212	0.00186	0.00183
28	0.54738	0.54738	0.54738	0.25500	0.25499	0.25498	0.04942	0.04852	0.04850
29	0.90107	0.90107	0.90107	0.15535	0.15534	0.15534	0.03035	0.02980	0.02979
30	0.32646	0.32646	0.32646	0.12850	0.12849	0.12849	0.01014	0.00957	0.00955
31	0.30620	0.30620	0.30620	0.12783	0.12782	0.12780	0.01164	0.01098	0.01096
32	0.30607	0.30607	0.30607	0.07334	0.07333	0.07332	0.00621	0.00566	0.00565
33	0.31262	0.31262	0.31262	0.10594	0.10592	0.10590	0.00759	0.00671	0.00670
34	0.74772	0.74772	0.74772	0.08979	0.08979	0.08980	0.05175	0.00666	0.00663
35	0.29395	0.29395	0.29395	0.04943	0.04941	0.04940	0.00200	0.00179	0.00177
36	0.49504	0.49504	0.49504	0.12240	0.12239	0.12239	0.00230	0.00156	0.00154
37	0.24363	0.24363	0.24363	0.06556	0.06553	0.06552	0.00329	0.00296	0.00292
38	0.47695	0.47695	0.47695	0.08339	0.08338	0.08337	0.00396	0.00375	0.00373
39	0.30028	0.30028	0.30028	0.11863	0.11862	0.11861	0.00207	0.00182	0.00180
40	0.25527	0.25527	0.25527	0.07477	0.07476	0.07475	0.00220	0.00189	0.00187
41	0.21556	0.21556	0.21556	0.07308	0.07307	0.07307	0.00214	0.00166	0.00164
42	0.19412	0.19412	0.19412	0.06930	0.06929	0.06929	0.00207	0.00155	0.00153
43	0.20208	0.20208	0.20208	0.06473	0.06472	0.06471	0.00219	0.00170	0.00169
44	0.19749	0.19749	0.19749	0.06427	0.06426	0.06426	0.00344	0.00173	0.00171
45	0.23039	0.23039	0.23039	0.07407	0.07406	0.07406	0.00660	0.00437	0.00435
46	0.15016	0.15016	0.15016	0.05107	0.05107	0.05106	0.00287	0.00257	0.00256
47	0.19024	0.19024	0.19024	0.05812	0.05811	0.05811	0.00276	0.00184	0.00183
48	0.20485	0.20485	0.20485	0.07886	0.07885	0.07885	0.00254	0.00163	0.00161
49	0.25597	0.25597	0.25597	0.06867	0.06865	0.06865	0.00378	0.00311	0.00309
50	0.49942	0.49942	0.49942	0.09540	0.09538	0.09538	0.01764	0.01737	0.01735
51	0.19661	0.19661	0.19661	0.07099	0.07098	0.07098	0.00384	0.00292	0.00291
52	0.16367	0.16367	0.16367	0.04563	0.04562	0.04561	0.00149	0.00117	0.00116
53	0.99511	0.99511	0.99511	0.80033	0.80032	0.80031	0.00077	0.00048	0.00046
54	0.08883	0.08883	0.08883	0.05159	0.05158	0.05158	0.00044	0.00037	0.00036
55	0.16355	0.16355	0.16355	0.06580	0.06575	0.06574	0.00122	0.00076	0.00069
56	0.05975	0.05975	0.05975	0.01992	0.01991	0.01991	0.00067	0.00049	0.00049

For sectors specification, see appendix 3.1.

	COD			Oil & Greases		
Tech.→ Sect.↓	I	II	III	I	II	III
1	0.00831	0.00829	0.00829	0.00079	0.00079	0.00079
2	0.07201	0.07199	0.07200	0.00236	0.00236	0.00236
3	0.02268	0.02267	0.02266	0.00025	0.00025	0.00024
4	0.00143	0.00140	0.00140	0.00010	0.00010	0.00010
5	0.00862	0.00857	0.00857	0.00106	0.00106	0.00106
6	0.00194	0.00191	0.00191	0.00020	0.00019	0.00019
7	0.00998	0.00990	0.00991	0.00101	0.00101	0.00100
8	0.02324	0.02320	0.02321	0.00111	0.00111	0.00111
9	0.00770	0.00766	0.00764	0.00068	0.00068	0.00067
10	0.01650	0.01646	0.01646	0.00109	0.00109	0.00109
11	0.01823	0.01818	0.01817	0.00094	0.00094	0.00093
12	0.00784	0.00780	0.00779	0.00063	0.00063	0.00061
13	0.00682	0.00679	0.00678	0.00056	0.00056	0.00056
14	0.03981	0.03976	0.03976	0.00191	0.00191	0.00191
15	0.03476	0.03471	0.03470	0.00157	0.00157	0.00155
16	0.01516	0.01512	0.01513	0.00066	0.00065	0.00065
17	0.12625	0.12620	0.12620	0.00129	0.00129	0.00129
18	0.01181	0.01175	0.01172	0.00130	0.00130	0.00130
19	0.00568	0.00565	0.00565	0.00040	0.00040	0.00040
20	0.02061	0.02056	0.02021	0.00150	0.00149	0.00149
21	0.01080	0.01076	0.01067	0.00090	0.00090	0.00090
22	0.01667	0.01664	0.01664	0.00073	0.00073	0.00073
23	0.03242	0.03239	0.03239	0.00061	0.00061	0.00061
24	0.05845	0.05841	0.05840	0.00115	0.00114	0.00114
25	0.05444	0.05440	0.05439	0.00112	0.00112	0.00110
26	0.00502	0.00312	0.00303	0.00040	0.00032	0.00029
27	0.00878	0.00871	0.00871	0.00117	0.00117	0.00117
28	0.14625	0.14620	0.14619	0.00225	0.00224	0.00224
29	0.05606	0.05601	0.05601	0.00738	0.00738	0.00738
30	0.03620	0.03613	0.03612	0.00186	0.00186	0.00181
31	0.04093	0.04088	0.04087	0.00275	0.00275	0.00274
32	0.02281	0.02277	0.02274	0.00239	0.00239	0.00228
33	0.02925	0.02920	0.02919	0.00150	0.00150	0.00149
34	0.14336	0.14332	0.14331	0.00120	0.00120	0.00120
35	0.01271	0.01263	0.01263	0.00090	0.00090	0.00089
36	0.02176	0.02170	0.02170	0.00209	0.00209	0.00209
37	0.01593	0.01581	0.01582	0.00102	0.00101	0.00101
38	0.01661	0.01654	0.01654	0.00128	0.00128	0.00128
39	0.01641	0.01636	0.01636	0.00185	0.00185	0.00185
40	0.01302	0.01297	0.01297	0.00114	0.00114	0.00114
41	0.01252	0.01247	0.01247	0.00111	0.00111	0.00111
42	0.01172	0.01167	0.01167	0.00105	0.00105	0.00105
43	0.01145	0.01140	0.01140	0.00098	0.00098	0.00098
44	0.01486	0.01481	0.01480	0.00097	0.00097	0.00095
45	0.02384	0.02380	0.02379	0.00103	0.00103	0.00102
46	0.01207	0.01205	0.01204	0.00083	0.00083	0.00083
47	0.01218	0.01214	0.01215	0.00087	0.00087	0.00087
48	0.01450	0.01445	0.01446	0.00124	0.00124	0.00124
49	0.02272	0.02266	0.02266	0.00097	0.00096	0.00096
50	0.05707	0.05702	0.05702	0.00112	0.00111	0.00111
51	0.01731	0.01727	0.01727	0.00106	0.00106	0.00106
52	0.00896	0.00893	0.00893	0.00078	0.00078	0.00078
53	0.07289	0.07284	0.07285	0.01204	0.01204	0.01204
54	0.00663	0.00661	0.00661	0.00079	0.00079	0.00079
55	0.00967	0.00948	0.00950	0.00102	0.00101	0.00101
56	0.00397	0.00396	0.00396	0.00033	0.00033	0.00033

over the others, but to examine the status of pollution abatement in India. For that purpose the standard results of the three techniques are compared with the actual intensity results (chapter 4). Thus, we now, compare the actual after abatement direct-indirect intensity with the direct-indirect intensity of the three abatement techniques. As will be seen in the analysis that for some sectors actual intensity has far exceeded, the intensity results of different abatement techniques.

Table 6.2 shows that in the case of suspended solids (2) the actual intensity has exceeded on a large scale. The maximum difference between actual intensity and intensity results of the three techniques is observed in the case of drugs and medicines (32) industry. The actual intensity of this sector has exceeded by more than 100 percent with that of three alternatives. For other sectors such as paper and pulp (20), other livestock products (3), paint and varnishes (31), printing and publishing (21), other services (56) and tobacco products (13), the actual intensity exceeded by only 10 to 40 percent. In the case of suspended solids we find that for the sectors such as, fertilizer (29), non-ferrous basic metal (39), metallic mineral (7), gas and water supply (54), electricity (53), and dairy products (2), actual intensity results are almost similar with that of first abatement technique results. Beverages (12) is the only sector in which reduced intensity is being observed in comparison to the intensity of all the three abatement techniques.

In the case of BOD (3), the actual direct-indirect water pollution intensity in most of the sectors is found to be several times higher than the three abatement techniques. As is seen that the actual intensity for beverages (12) and drugs and medicines (32) is several times higher than the intensity provided by three abatement techniques. For the industries such as paper and pulp (20), other services (56), printing and publishing (21), art silk, synthetic fiber textiles (17), other livestock products (3), silk textiles (16), tobacco products (13), wood and wooden products (19), electricity (53), coal and lignite (5), forestry, logging and fishing (4), paint and varnishes (31) and crude petroleum (6), the actual intensity of discharge exceeds by around 100 to 800 percentage points from the intensity of the first technique. For second and third

Table 6.2: **Differences between Actual Pollution Intensity and Intensity of Three Abatement Techniques, 1993-94 (in percent)**

	Sus. Solids			BOD			COD			Oil & Greases		
Tech.→ Sect.↓	I	II	III	I	II	III	I	II	III	I	II	III
1	1	1	1	13	16	17	17	18	18	7	7	7
2	1	1	1	2	3	3	2	2	2	4	4	4
3	45	45	45	681	732	737	-47	-47	-47	67	68	68
4	3	4	4	85	142	157	94	99	98	33	34	35
5	1	1	1	67	111	117	43	43	43	9	9	9
6	2	2	2	63	100	109	58	61	61	20	21	21
7	1	1	1	39	60	65	25	26	26	7	7	7
8	1	1	1	9	12	13	7	7	7	4	4	4
9	3	3	3	54	63	64	98	99	99	35	36	36
10	2	2	2	21	27	27	34	35	35	14	14	14
11	4	4	4	54	67	68	35	35	35	29	29	29
12	-33	-33	-33	4228	6964	7879	190	192	192	27	28	28
13	9	9	9	174	234	237	318	320	321	38	39	39
14	2	2	2	53	110	111	21	21	21	9	9	9
15	2	2	2	63	154	156	23	23	23	12	12	12
16	4	4	4	125	321	326	34	34	34	24	25	25
17	2	2	2	448	1701	1720	16	16	16	15	16	16
18	1	1	1	72	122	126	40	40	40	11	11	11
19	3	3	3	89	288	296	110	111	111	25	25	25
20	43	43	43	780	896	896	2002	2007	2044	12	13	13
21	20	20	20	438	543	547	983	987	995	16	16	16
22	3	3	3	48	85	86	40	40	40	29	30	30
23	2	2	2	20	26	26	21	21	21	40	40	40
24	2	2	2	42	160	161	32	32	32	18	19	19
25	2	2	2	49	671	675	60	60	60	13	13	13
26	-1	1	2	0	21	211	48	138	124	30	65	78
27	2	2	2	51	72	74	74	76	76	21	21	21
28	1	1	1	5	7	7	13	13	13	20	20	20
29	1	1	1	4	6	6	14	14	14	3	3	3
30	3	3	3	48	57	57	76	76	76	43	43	43
31	15	15	15	75	86	86	139	139	140	1	1	1
32	184	184	184	2069	2279	2284	2597	2601	2605	2045	2046	2047
33	3	3	3	37	55	55	80	80	80	21	21	21
34	3	3	3	47	1045	1051	55	55	55	17	17	17
35	2	2	2	41	57	59	46	47	47	15	16	16
36	1	1	1	45	114	117	25	25	25	7	7	7
37	1	1	1	24	38	40	31	32	32	15	15	16
38	1	1	1	22	29	30	31	32	32	16	16	16
39	1	1	1	42	61	63	34	34	34	9	9	9
40	1	1	1	45	68	70	46	46	46	16	16	16
41	1	1	1	51	94	97	49	50	50	17	17	17
42	2	2	2	60	113	116	61	61	61	22	23	23
43	1	1	1	48	90	92	52	52	52	19	20	20
44	2	2	2	54	206	209	68	68	68	20	20	20
45	2	2	2	35	104	105	57	57	57	18	18	18
46	6	6	6	75	96	97	111	111	111	41	41	42
47	1	1	1	37	105	107	43	43	43	13	14	14
48	1	1	1	57	146	148	54	54	54	17	17	17
49	2	2	2	38	67	69	39	39	39	22	22	22
50	1	1	1	7	9	9	16	16	16	19	19	19
51	2	2	2	40	84	85	54	55	55	15	16	16
52	2	2	2	61	105	107	57	58	58	20	20	20
53	0	0	0	99	225	237	6	6	6	1	1	1
54	1	1	1	109	153	158	22	22	22	8	8	8
55	1	1	1	80	192	220	64	67	67	16	17	17
56	11	11	11	342	503	509	296	297	297	211	211	211

For sectors specification, see appendix 3.1.

techniques it is even further high. The remaining sectors have also experienced the increased actual intensity in comparison to the first technique (and others also), except for dairy (2) industry. The discharge by this sector shows no change in intensity with all the abatement alternatives. As is seen in the table 6.2 that beverages (12), art silk synthetic fiber textiles (17), drugs and medicines (32), synthetic fiber, resins (34) and paper and pulp (20), are the sectors for whom 600 to 900 percentage point increase has been observed for the third abatement technique. All remaining sectors have registered increased discharge intensity that varies from low to high range.

As far as pollution intensity of COD (4) is concerned, the actual intensity has exceeded from the intensity of three abatement techniques in sectors such as, paper and pulp (20), drugs and medicines (32) and printing and publishing (21). The actual direct-indirect intensity for these sectors is exceeded by more than 1000 percentage point in the case of all the three abatement techniques. The sectors such as other services (56), tobacco products (13), paint varnishes (31), forestry, logging and fishing (4), sugar (9) and wood and wooden products (19), an increase of around 100 to 400 percentage point has been observed for all the techniques. The remaining sectors have also experienced the higher actual intensity in comparison to the available abatement techniques that ranged between 2 percent to 100 percent. Other livestock product (3) is the only sector showing reduction in intensity of COD. Unlike the BOD, in the case of COD there is not much difference seen among the intensities of different techniques.

In the case of oil and greases the actual difference in the level of pollution intensity with all the three alternatives has not been very significant. Drugs and medicine (32) has shown the highest intensity in comparison to all the abatement techniques. The actual intensity of this sector exceeds by more than 2000 percentage points. Other services (56) sector is the second that has appeared with high intensity in comparison to all the techniques. All other sectors have shown the increased actual intensity ranging from 2 percent to 90 percent in all the years under consideration. Paint and varnishes (31) is the only sector having reduced actual intensity in comparison to all the three alternatives.

After discussing the actual status of pollution abatement at dis-aggregated level, we now look into the status of pollution control from the perspective of aggregate pollution generation. In the following section changes in aggregate pollution generation are discussed.

6.2.2 The Aggregate Pollution Abatement

Table 6.3 shows the aggregate quantity of pollution generation during 1983-84, 1989-90 and 1993-94. The quantity generated by all different techniques are shown in different rows. The columns indicate years of reference. Like in the previous case here too, no difference in total quantity of effluents has appeared. However for other pollutants significant differences can be observed.

In the case of suspended solids (2) there is very little variation found in the total pollution generation among the different abatement techniques in all the years under consideration. This difference is only of 0.05 to 0.07 percent. The total quantity generation of BOD (3) is significantly different with respect to all the three techniques. The first technique generate 13 percent to 15 percent higher quantity in comparison to the second technique and 14 to 15 percent higher quantity in comparison to the third abatement technique.

As far as COD (4) and oil and greases (5) are concerned again there is not much difference observed in the total quantity of pollution among the three abatement techniques. It ranges from 0.4 to 0.5 percent for both the pollutants and for all the techniques.

Table 6.3 presents the aggregate quantity of different pollutants from three abatement techniques. The percentage increase of actual quantity with that of the quantity of different abatement techniques are shown in the brackets of table 6.3. Now if we compare the results of three abatement techniques with that of actual quantity results obtained in different time periods then we find that mainly differences have been ob-

Table 6.3: **Aggregate Pollution Output**

(Effluent quantity is in thousand cu.m. and other pollutants in tons)

Pollutants	Abatement Techniques	1983-84	1989-90	1993-94
Effluent Quantity	I	5597907	8935330	11694333
	II	5597907	8935330	11694333
	III	5597907	8935330	11694333
Suspended Solids	I	1495150	2663998	3632426
		(3)	(4)	(-24)
	II	1494373	2662918	3631583
		(3)	(4)	(-24)
	III	1494236	2662723	3631422
		(3)	(4)	(-24)
BOD	I	96707	168707	191413
		(101)	(109)	(95)
	II	84696	142665	151788
		(130)	(148)	(147)
	III	83590	141117	150517
		(133)	(150)	(149)
COD	I	601082	992413	1181588
		(51)	(62)	(44)
	II	598058	988181	1178234
		(51)	(62)	(45)
	III	598248	988409	1178293
		(51)	(62)	(45)
Oil and Greases	I	31699	55773	70040
		(46)	(59)	(40)
	II	31564	55584	69890
		(47)	(60)	(41)
	III	31526	55530	69848
		(47)	(60)	(41)

Figures in brackets indicate percentage increase of actual intensity w.r.t. three abatement techniques.

served in the case of BOD (3), then followed by COD (4). In the case of suspended solids (2) the actual discharge of the quantity exceeds by around 3 to 4 percent with regard to all the abatement techniques. For BOD (3) this percentage appear to be higher and the actual quantity exceeds by around 100 percent with first alternative, whereas 130 to 133 percent for second and third alternative. In all the years similar trend has been followed. The quantity increase of around 110 percent to 150 percent is observed. For COD (4) and oil greases (5) the similar increase of the actual quantity has been observed. The actual quantity exceeds by around 50 to 60 percent in all the years with all the three abatement techniques.

6.3 Summary

In the present analysis we have compared the level of pollution from three different abatement techniques. These abatement techniques have been arranged in a descending order so that first technique becomes least efficient in terms of pollution abatement and third technique is most efficient.

The actual data could be obtained only for the 12 sectors of the input-output table. For rest of the sectors after abatement data was borrowed from the actual direct pollution matrix used in earlier chapters. Thus, results accomplished in this chapter have basically reflected the changes of only those 12 sectors. In spite of these limitations we have been able to analyze the different cases related with pollution abatement. To an extent present analysis has been able to provide information regarding pollution control status of the Indian economy. If it would have possible to get data at least for all highly polluting sectors then our results would have given more realistic picture.

The analysis has been performed on five water pollution parameters– namely, effluent quantity, suspended solids, BOD, COD and oil greases. There is very little difference has been found in the pollution intensity of the three techniques. In the case of BOD and COD some significant differences among the three techniques have

been observed. As a second step of analysis these results are compared with the actual pollution intensity results. It was found that actual intensity has far exceeded the pollution intensity of the three standard techniques. While comparing the two results we have clearly observed the efficiency of tertiary level abatement technique over the others. Thus, if it is possible to perform tertiary level abatement in some of the sectors then level of pollution can be reduced substantially. The present analysis shows that situation has not been very satisfactory on account of pollution abatement during the past several years. Almost in all the sectors the actual level of abatement is low in comparison to the abatement level of the three abatement alternatives considered in the analysis. Even if we assume the standards provided by the least efficient technique are to be followed then also the real situation become far from satisfactory. This is because in most of the cases actual intensity of different sectors has significantly exceeded the intensity generated by even first technique. The situation is most severe for BOD.

Chapter 7

Summary and Conclusions

7.1 The Perspective of the Study and Major Findings

This study analyzes that how level of pollution is the result of economic-interdependence among the different sectors of the economy. The major objectives of the study are–(1) to study the intensity of water pollution in the different sectors of the economy; (2) to study the effects of technological change on pollution generation over a period of time and (3) to examine the status of pollution control through different abatement techniques. The term pollution intensity has been used to indicate the total (direct plus indirect) generation of pollution. The pollution intensity intends to explain units of the physical pollution output expressed in money value of economic sectors. Thus, these units indicate generation of pollution in cu.m./tons per lakh rupees of output.

For the above mentioned objectives 'open, static Leontief' type input-output model is applied. Input-Output model is essentially a simplified model of production, which takes into account the interdependencies among producing sectors of the economy. The input-output (I-O) table traces the level of output of each sector of a given national economy in terms of its relationship to the corresponding level of activities

in all the other sectors. The output of a particular sector depends upon two things– firstly, the amount of quantity demanded by the consumers or households, and secondly, the input requirements of the other sectors of the economy using the output of that sector as an input. Generation of pollution is a regular feature of the production and consumption process, thus, can be referred as an undesirable by-product of the activities. The level of pollution directly varies with the level of output. Any change in the output level of pollutants is the result of either a change in the final demand of specific goods and services or changes in the technological structure of one or more sectors of the economy, or a change in the combination of these two factors.

The present study focuses on the issue of pollution generation that arises because of the inter-relations between the different sectors of the input-output table. For this purpose the data on industrial water pollution is combined with the economic sectors in a meaningful manner so that it appears as an extension of the input-output table to cover the environmental repercussions. These effects can be studied by number of input-output models available for the analysis. For the present purpose input-output model of the generalized nature has been considered, where extra rows and columns are used to represent the generation and abatement of pollution. The models of Leontief (1970) and Leontief and Ford (1972) are of this kind. All environmental input-output models are some forms or a transformation of the Leontief model and most of them are extension to the Leontief's formulation. The model has wide range of scope for the empirical analysis and quite suitable for the present analysis. Therefore it has been used for the present purpose.

Empirically, very little use has been made of these models to study the industrial water pollution. In most of the empirical literature energy based emissions have been calculated. The studies of Leontief and Ford (1972) for USA, Miernyk and Sears (1974) for West Virginia USA, James et al. (1978) for Netherlands, Forsund and Strom (1976) for Norway are such examples. But most of these studies have been conducted for the air pollutants. No such attempts have been made on water pollution. The present study is an attempt in this direction and it aims to assess industrial water pollution in

India by using the input-output framework.

The input-output transaction table (IOTT) for the years 1983-84, 1989-90 and 1993-94 provide the prime data source for the present study. These tables are prepared by the Central Statistical Organization (CSO) at the current prices for 115 detailed sectors. In order to make all tables consistent with each other for comparison, these tables have been converted to the common base at 1993-94 prices. Center for Monitoring Indian Economy (CMIE 1989, 1991, 1993, 1994) price indices and National Accounts Statistics (NAS) figures have been used for this purpose. Another adjustment has been done in terms of number of sectors; original 115 sectors have been aggregated to 56. These sectors are formed on the basis of their environmental consequences and also on economic rationale.

The other set of data that is required for the generation of environment matrix has been collected from the different secondary sources. However, the main source of data for this purpose is Central Pollution Control Board (CPCB) and Uttar Pradesh State Pollution Control Board (SPCB). The environment matrix has been formed for 36 different organic, inorganic and toxic pollutants.

There are three categories of sectors found– firstly, some of the sectors are non-polluting and hence generated zero-pollution. Out of 56 sectors, 6 sectors such as, agriculture (1), forestry, logging and fishing (4), printing and publishing (21), construction (52), gas and water supply (54), and other services (56) are of this nature. The second category is of low/moderately polluting sectors. They include coal and lignite (5), crude petroleum and natural gas (6), metallic minerals (7), non-metallic minerals (8), tobacco products (13), wood and wooden products (19), leather footwear (22), coal tar products (27), structural clay products (35), cement (36), metal products including hand tools (40), tractors and agriculture implements (41), industrial machinery (42), machine tools and other non-electrical machinery (43), electrical and electronic equipment (44), ships and boats (46), rail equipment (47), motor vehicles and scooters (48), cycle, rickshaw and other transport equipment (49), watches and

clocks (50), miscellaneous manufacturing (51), and transport services (55). The third and most important category is of highly polluting sectors. The remaining 28 sectors not mentioned above, are under this category. In this way there are three categories of sectors found non-polluting, low/moderately polluting and highly polluting sectors.

It has been mentioned earlier, the first issue to be examined in detail was the water pollution intensity. This issue has been investigated from two different perspectives. Firstly, the direct pollution coefficients have been analyzed to study the water pollution behavior of individual industrial categories and secondly, the direct plus indirect pollution intensity has been calculated in order to derive the total pollution as a result of inter-relatedness among different sectors. Several exercises have been performed to study these objectives.

Firstly, we have tried to examine the nature of direct pollution intensity. For this purpose as a first exercise we have analyzed in detail, the change in composition of effluents before and after abatement. This has been done in order to find the status of residual generation and level of abatement in individual industrial categories. The level of abatement is important because it is the final effluent that is discharged into the environment. Thus, actual quality of environment to an extent depends on the level of abatement carried at an individual industries' level. In the second step we have examined the relative share of all the sectors of the input-output table. This analysis explains, how much direct pollution intensity is contributed by each of the individual sectors. For this the relative share of individual sectors in total direct pollution is calculated. This exercise gives an idea about the direct pollution potential of the different sectors of the input-output table. Lastly, the share of highly polluting industries in total direct pollution intensity is calculated to know about the pattern of industrial pollution in highly polluting sectors. This allowed us to provide the ranking among the highly polluting sectors. The last exercise was important from the policy point of view. These exercises have been mainly performed to examine the pollution potential of different sectors of the economy.

In order to find the total intensity, direct plus indirect coefficients have been calculated from two perspectives. Firstly, analysis is done by taking the pollution coefficients of all the sectors and secondly, separate analysis is being performed for highly polluting sectors. The first exercise calculates direct plus indirect pollution intensity because of the interaction effect of all the sectors whereas the second exercise gives the pollution intensity as a result of highly polluting sectors only. The pollution intensity of highly polluting industries is calculated by taking the direct pollution coefficients of only the highly polluting sectors and assuming the pollution from other sectors to be zero. This gives an insight into the extent of inter-relatedness among the industries that are responsible for much of the industrial pollution. In addition to this, the relative share of individual industrial categories in total pollution intensity are also calculated. This allowed us to know about the strength of each sector in pollution generation.

Lastly, final demand intensity has been calculated to describe the generation of total pollution associated with the category of final demand for the entire economy. For the purpose of present analysis final demand category has five components, namely, private final consumption expenditure (PFCE), government final consumption expenditure (GFCE), gross investments (GI), exports (EXP) and imports (IMP). The sub-division of this kind gives further insight into the analysis that how each component of final demand can influence the level of pollution.

The direct pollution intensity results show that some of the highly polluting sectors such as, dairy (2), beverages (12), textile (14,17), paper (20), leather (23), rubber (24), heavy chemicals (28). fertilizers (29), drugs (32), synthetic fiber (34) etc, have been found with highest intensity. The first exercise in the case of direct pollution intensity was to analyse the level of abatement in different sectors. The analysis shows that the level of abatement varies with each sector and for every pollutant. In general level of abatement among the highly polluting industries has been high. In very few instances it has been observed that the non-abatement sectors are from highly polluting category. In most of the polluting industries for most of the pollutants more than 80

percent of the pollutants are treated.

As a second exercise the relative share of industries in direct pollution coefficients have been calculated. The analysis indicates that highly polluting industries are responsible for the bulk of the discharge of most of the pollutants. Hence a major share in direct pollution generation is held by the sectors of this category. For example 64 percent of the total effluent quantity (1) is discharged by the highly polluting industries. In the case of dissolved phosphate (36), potassium (33), nitrate nitrogen (14), organic nitrogen (13), total nitrogen (12), total volatile solids (6), dissolved fixed solids (5), mercury (24), fluorides (26), lead (21), zinc (17), oil and greases (9), total suspended solids (2), chromium (19), biological oxygen demand (7), iron (15), aluminium (34), total dissolved solids (3), and chemical oxygen demand (8), the highly polluting industries have generated more than 90 percent pollution.

The results regarding total water pollution intensity (direct plus indirect) indicates that still highly polluting sectors are present with high pollution intensity. Sectors such as, drugs and medicines (32), coal and lignite (5), paper and paper based products (20), synthetic fiber, resins (34), coal tar products (27) and electricity (53) have appeared with highest intensity. Apart from this, sectors such as sugar (9), textiles (14-18), beverages (12), food products (11), leather (23), pesticides (30), paint and varnishes (31) have also shown high intensity for most of the pollutants. We find that the relative ranking of industry changes when direct-indirect coefficients are taken into account.

The indirect effect is found to be highest in coal tar product (27), drugs (32), paper (20), electricity (53), cement (36), printing and publishing (21), plastic product (25), synthetic fiber (34), iron and steel (38). Most of the engineering sectors (40-50), have generated high indirect effect. The direct effect was very low in the case of engineering (40-49) sectors. In the same way, agriculture (1), cement (36), printing and publishing (21), construction (52) were discharging zero/negligible pollution directly but indirectly these sectors have generated substantial quantity of pollution.

There are sectors in which direct effect is very significant but their indirect effect is comparatively small. Sectors such as, dairy (2), other livestock product (3), sugar (9), leather (23), edible oil (10), beverages (12), are of this variety.

From this analysis, three important categories of sectors have clearly emerged. Firstly, sectors in which there is high direct and high indirect effect. Secondly, sectors in which high direct effect but indirect effect is not very significant. Thirdly, there are sectors in which direct pollution intensity is very low but the indirect intensity component is very high. All these categories are cause of concern. The uniqueness of the input-output technique is in finding the third category.

As already mentioned, the direct-indirect intensity has been analyzed from two perspectives, firstly interaction effects of 'all sectors' of the input-output table have been studied. secondly, separate analysis has been done to examine the inter-relatedness among the 'highly polluting' sectors. The results discussed so far were related to all sectors of the input-output table. The interaction effect of highly polluting sectors show that most of the pollution in the economy is generated by the sectors of the highly polluting category.

Lastly, analysis has been done for final demand intensity. If we divide the entire final demand category into three components, viz. consumption, investments, and exports. We find that the highest contribution is made by the consumption category, in which private final consumption expenditure (PFCE) has the maximum contribution, then followed by the gross investments.

The next issue that has been examined in detail is the residual flows and technical change. In input-output analysis technology is represented by the I-O coefficients. The basic methodology is adopted from Carter (1970), Leontief (1972) and Forssell (1988). This has been done by comparing the two input-output tables in base period $'0'$ and current period $'t'$. Contribution of technical change in the form of changing $a_{ij}s'$ has been estimated in aggregate as well as for individual industrial category. This exercise tells us how pollution discharged by the various industries changes if we keep final

demand vector constant and change the $'A'$ matrix only from the base year to the current year.

The analysis of technical change has been performed for the two different sub-periods; 1983-84 to 1989-90 and 1989-90 to 1993-94, along with this separate analysis for the entire period 1983-84 to 1993-94 has also been performed. The technical change in highly polluting industries has also been studied separately. It is found that there has been technological deterioration during the first sub-period. It is found that 1989-90 technology has generated 26 percent increased effluent quantity in comparison to the 1983-84 technology. For highly polluting industries this increase has been around 30 percent. For other pollutants also the high growth of pollution was evident. All pollutants have shown high positive growth of pollution.

During the second sub-period of 1989-90 to 1993-94 a slight improvement in terms of pollution generation is seen, though some of the pollutants continue to show positive growth trend. For most of the pollutants negative growth is prominent, which is definitely the result of improved technology in 1993-94. Most important of all is the reduction in the effluent quantity of highly polluting industries. During 1989-90 to 1993-94 effluent quantity increased by around 4 percent for all industries, while for highly polluting industries, there was a reduction of around 2 percent. All major pollutants such as insoluble solids, BOD, COD, oil and greases, nitrogenous and toxic pollutants, have shown highly negative contribution.

For the entire period 1983-84 to 1993-94, the overall situation worsens. Almost all pollutants have shown high positive growth with 1993-94 technology in comparison to 1983-84 technology. All major pollutants have appeared with high positive growth. Thus, the effect of technology on aggregate pollutants, show a deterioration in technology. This implies that over a period of time input technology has generated more pollutants.

The disaggregated analysis of technological change also confirm the technological deterioration in terms of environment, in most of the sectors of the economy. During

the first sub-period of 1983-84 to 1989-90 the maximum positive growth for effluent quantity (1) with 1989-90 technology has been experienced by the other services (56), agriculture (1) and construction (52) sector. The sectors showing improvement in technology include–iron steel (38), transport services (55), heavy chemicals (28) , non-ferrous basic metal (39), electricity (53), other livestock products (3), miscellaneous manufacturing (51) etc. The industries such as sugar (9), edible oil (10), food products (11), beverages (12), tobacco (13), textiles (14-18), leather (23), rubber (24), plastics (25) fertilizer (29), paint varnishes (31), drugs and medicines (32), other chemicals (33), synthetic fibers (34), batteries (45) have shown positive growth which implies a deterioration in technology in the case of most of the pollutants.

During 1989-90 to 1993-94 considerable number of highly polluting industries have started showing negative growth of pollution. The industries such as sugar (9), beverages (12), textiles(14-18), leather (23), petroleum product (26), fertilizer (29), drugs and medicines (32) which hardly showed any sign of improvement in earlier time period, have now started showing negative effect in many instances. Transport services (55) and construction (52) seems to have highest positive growth in the case of some of the pollutants. But construction sector has also shown signs of considerable improvement for some of the pollutants. Other services (56) sector has shown maximum improvement.

For the entire period 1983-84 to 1993-94 the situation is very much similar to that of first sub-period. Here too, construction (52), transport services (55), and other services (56) appear to be most polluting in terms of technology deterioration. Other polluting sectors such as dairy (2), sugar (9), hydrogenated oil (10), tobacco products (13), cotton textiles (14), rubber (24), plastics (25) and other chemicals (33) have also contributed substantially. Overall, technological analysis shows that over a period of time input technology has not produced environment friendly results. Thus, at the end of each time period level of pollution has generally been on increase.

The next issue of the analysis is abatement techniques and status of effluent

treatment in all the sectors of the input-output table. The cross impacts of the three abatement techniques are considered for comparison. The data on three techniques is taken from the standard theoretical values that shows the level of pollution when a particular abatement technique is adopted. Thus, the results reflect an ideal standard situation that states, how much should be the standard pollution level when three techniques are adopted one-by-one. The two main objectives are examined in this analysis. Firstly, status of pollution abatement from three different techniques is examined. Secondly, the actual pollution intensity (analyzed in chapter 4) is compared with the pollution intensity of three abatement techniques. For this purpose analysis has been done at aggregated as well as at dis-aggregated level. For the second objective, after abatement intensity results of chapter 4 are compared with the after abatement results obtained from the three abatement techniques. The analysis has been performed for the five water pollution parameters, namely, effluent quantity, suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD) and oil and greases for all the years under consideration.

In the case of suspended solids and oil greases the differences in pollution intensity from the three techniques, are not very significant. In the case of BOD, sectors such as synthetic fiber resins (34), art silk, synthetic textiles (17), plastics (25), petroleum product (26), beverages (12), woolen textile (15), rubber products (24), crude petroleum (6) and cotton textiles (14), the third technique prove to be very efficient and has produced more than 10 percent reduced intensity of BOD in comparison to the first technique. In the case of COD also the same trend has appeared.

The comparison of actual after abatement pollution intensity results (chapter 4) with that of three abatement techniques shows that in the case of almost all the pollutants actual intensity was more than 100 times greater than the intensity of the three abatement techniques. Drugs and medicines (32) has experienced highest intensity that exceeds by 119 percent to standard intensity values obtained from three abatement techniques. In the case of BOD, the actual intensity for beverages (12) and drugs and medicines (32) is several times higher than the intensity provided by three

abatement techniques. In the case of third abatement technique the intensity is 60 times higher for beverages (12) industry. For other sectors such as, paper and pulp (20), other services (56), printing and publishing (21), art silk, synthetic fiber textiles (17), other livestock products (3), silk textiles (16), tobacco products (13), wood and wooden products (19), electricity (53), coal and lignite (5), forestry, logging and fishing (4), paint and varnishes (31) and crude petroleum (6), the actual intensity exceeds by around 100 to 800 percentage points of the intensity of the first technique (least efficient). The actual discharge of COD has also exceeded the three standard alternatives considered in the present analysis. The main sectors with highest increase in intensity are paper and pulp (20), drugs and medicines (32) and printing and publishing (21).

Overall, the results indicate that the situation has not been very satisfactory on account of pollution abatement. The actual pollution level in most of the sectors has exceeded the standard norms provided by the three abatement alternatives. Even if we assume that the standards provided by the least efficient technique i.e. first abatement technique, are to be followed nevertheless the real situation becomes far from satisfactory.

With the present study it can very well be concluded that the situation of industrial pollution in India during the past several years has not gained much attention. Consequently, the real situation has worsened over a period of time. Though several measures to improve the functioning of environmental legislation have taken place and they have provided some hope to the situation but the overall situation has deteriorated. We have seen that most of the pollution is generated by the sectors of the highly polluting category. Thus, the sectors under the highly polluting category needs special treatment. The sectors such as drugs and medicine, synthetic textiles, paper and pulp, chemicals, fertilizer have shown worst results in almost all the situations. Services and construction sector have absorbed maximum indirect effects. Thus, if pollution from the highly polluting sectors could be controlled then overall situation can be improved to an extent.

The direct-indirect intensity analysis has clearly identified three categories. Firstly, sectors with high 'direct' and high 'indirect' effect. Secondly, sectors in which the direct component is high but not the indirect. Thirdly, sectors that generate negligible pollution directly but their indirect effect is highly significant. For all these categories separate policy formulation is needed. Generally, sectors with low direct pollution potentials are considered environmentally safe. The indirect contribution of the sectors is not taken into account while declaring a sector polluting, highly polluting or non-polluting. In this analysis we have frequently come across the cases that many non-polluting sectors turn to be highly polluting when indirect intensity is taken into account. The overall effects on environment are determined by the direct as well as indirect pollution intensity. Ultimately, complete environment becomes polluted as a result of industrial activities. Whether pollution is generated directly by an industry where production takes place or indirectly in some other sectors, pollutants are discharged into the environment. Thus, indirect effects are important and should be incorporated in policy framework.

We have seen that input profile of the industries has not produced environment friendly results. Thus, if it is possible to improve the input usage in industries then, pollution can be controlled to an extent. The industries should not be encouraged to use the hazardous or polluting inputs in their process of production.

The present analysis implies that environmental consequences have not been given proper attention in India. The objective of high industrial growth has not been successful in setting goals for environmental quality. The weak structuring of environmental concerns in economic policy may be one of the reason for deterioration in environmental quality. Although in the recent decades there has been an increasing awareness about the environment which is reflected in all government plans and policies. Thus, the problem of rising industrial pollution in India is not because of the lack of realization of facts, but it is more a problem of management, control and monitoring on behalf of government. In the last part of the analysis we have seen that actual pollution intensity has far exceeded the pollution intensity standards provided by the three

standard abatement techniques. Thus, there should be strict monitoring for pollution abatement at the industry level. It seems that during the past several years inspite of the availability of the abatement techniques, measures have not been taken properly. Hence in reality the state of environment has been far below the required norms.

In this way present study attempts to highlight the problem of industrial pollution in its best possible manner. However, there are some limitations in this study. These limitations are discussed in the following section. The study also adds to the possibility of future research. Some of the issues could not be covered in this study. The following sections also describe those possibilities for future research.

7.2 Limitations of the Study and Scope for Future Research

The present study is able to draw a picture of the level and the status of industrial water pollution in India. Because of its comprehensive nature of analysis, the strengths of the study can broadly be categorized into four parts. Firstly, the data on industrial water pollution is combined in a meaningful way with the economic sectors of the input-output table. This facilitated to study the industry-environment relationship in an integrated form where it is possible to study the relationship between environment, factor inputs and final product. Hence inter-relationships between the environment and the economy are explicitly studied under this system modeling. Secondly, the model describes the economy a system of interdependent activities and enables analyst to trace the inter-industry linkages that account for both direct and indirect pollution generation in an economy. Thirdly, a considerable long period from 1983-84 to 1993-94 has been considered for the analysis. Fourthly, the study considers 36 different types of organic, inorganic and toxic water pollutants. Lastly, it provides a clear framework for the estimation of the water pollution potential of different sectors of the economy. Hence, it provides important information to the policy makers about how industries

are inter-linked for the generation of pollution. The industries with high inter-linkages may be targeted for pollution control.

Inspite of above strengths, the present study is not free from its limitations as well. Firstly, linear production function approach or constant returns to scale have been assumed. Hence the study does not incorporate the changes those arise in pollution generation because of scale of production. Secondly, the study employs standard static input-output model for analyzing water pollution intensity. The main drawback of the static model is, it considers economy at a single point of time. It is not able to describe the transaction that take place from one time period to another, due to its static nature. Thirdly, the changes in the input-output coefficients have been considered as a technological change. In reality technological change is a broader concept and need separate treatment. But in input-output analysis it is the best treatment for the analysis of technology. Fourthly, the pollution generation and abatement sectors could not be included in a single matrix. Lastly, it was not able to construct environment matrix for different time periods. But this limitation was not so severe because in the past few years effluent characteristics in different industrial categories have not changed much. This has been verified from the SPCB data survey.

All the above limitations of the present study were persisting because of the unavailability of data. For example to construct an environment matrix at different time periods requires large data base on industrial pollution. These data bases are generally not maintained by Indian industries. Similarly, very limited information is available on abatement cost, thus, very limited treatment has been given to the abatement techniques. The paucity of data compelled us to restrict ourselves with static model and constant returns to scale.

Inspite of these limitations the present study has made an important attempt that reveal the situation of industrial pollution in India in a significant manner. At least the impact of highly polluting industries that are responsible for most of the damage is very much clear from this study. The sectors that do not seem to generate high

direct pollution may generate more pollution indirectly. Construction and services are such examples. In this way it provide a reasonable guide to the policy makers and it prepares a good background for further extension and research.

Firstly, the model could very well be extended under the commodity-by-industry account to include the environmental by-products, where rows describe the commodities produced by the industries and columns are the industry sources of commodity production. Pollutants are the by-products produced by the industries in a process of production. Hence extra rows can be added showing each pollutant in a regular commodity-by-industry input-output table. The coefficients for the matrix are derived in a conventional manner of the Leontief system. It should be noted that by using this account we can easily compute ecological inputs and outputs as a function of final demand for industries as well as for commodities under the commodity based and industry based technology assumption.

The results of the study could be used for international comparison with the countries with which India is having close trade relationships. This would make the understanding simple that how countries are affected environmentally with international trade. With this information available it would be easy to understand which commodities a country should exports and which to import.

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